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June Dailies for Foreign Subscribers

Since the *American Engineer* has been enlarged and combined with the Shop Section of the *Railway Age Gazette,* it has been the practice to furnish the subscribers in America with copies of the eight *Daily Railway Age Gazettes,* issued during the Master Mechanics' and Master Car Builders' conventions during June. This has obviated the necessity of publishing a report of these conventions in the July number of the *American Engineer.* It was felt that the foreign subscribers to the *American Engineer* would not be specially interested in the *Dailies* and because of the additional expense involved they were not sent to them last year. It is the purpose to follow the same practice this year, although we shall be glad to furnish the *Dailies* to any of the foreign subscribers that express a desire to have them.

Ratio of Compound Cylinders

In most locomotives of the Mallet articulated type, it is desired to have the same amount of power delivered to both groups of wheels, and great care is given to so distribute the weight that the amount on each group will be the same. Long experience with two-cylinder compound engines has settled approximately the correct ratio of the area of the high to the low pressure cylinders. The same basis has been used for Mallet locomotives and a ratio from 2.4 to 2.5 has been accepted as good practice. In cases, however, where there are different numbers of drivers in the two groups, as has occurred on a few designs in this country, the designer is in a practically unknown and uncharted region. Furthermore it is sometimes possible to obtain a much more satisfactory design if an unequal distribution of weight on the two groups is allowed, even if there are the same number of wheels in each.

The first discussion of this interesting and important phase of the design of the Mallet locomotive to appear, in this country at least, is given on page 237 of this issue, under the heading of "Distribution of Power in Mallets," by Paul Weeks. Mr. Weeks has studied this subject most thoroughly, and has had an opportunity to experiment and prove the correctness of his contentions in practice. He points out exactly how the correct proportion of cylinders can be obtained under any condition of weight distribution and develops a new formula for giving the tractive effort of Mallet compound locomotives which is applicable to all cylinder proportions.

Water Glass Shields

An interesting detail in connection with the Lake Shore & Michigan Southern Mikados, which are described elsewhere in this issue, is the water glass shield. According to the report of the chief inspector of locomotive boilers for the year ending June 30, 1912, there were 165 accidents because of burst water glasses, resulting in one fatality and 168 injuries; there were also eight accidents because of defective water glass cocks and appurtenances. The accidents chargeable to the burst water glasses may be divided into two general classes—flying glass, and those due to scalding from the escaping steam and hot water. A shield made of wire netting —and these have been extensively used in the past—will not stop the finer particles of flying glass unless the mesh is very fine, in which case it is difficult and almost impossible to see the water level in the glass. Moreover the wire netting shields do not protect the enginemen from injury from the escaping steam and hot water. For this reason the government authorities have discouraged its use.

A general type of shield, which has met with much favor, has been that with a case fitted with slabs of heavy glass, arranged so that the water glass may be observed through them by either the engineer or fireman from the positions usually occupied by them in their work. There are several classes of this type of shield. An objection to some of the earlier forms was

that although injuries due to flying glass were eliminated, the shields were open at the bottom so that the escaping hot water would scald the firemen when in the act of shutting off the lower water glass cock. To remedy this difficulty the shields were closed at the bottom and opened at the back, so that the escaping water would be deflected against the boiler head. These are more satisfactory, but where the holes for the escaping water are not made sufficiently large the pressure due to the bursting of the tubular glass causes the heavy glass in the shield to break or crack. The new shield on the Lake Shore overcomes these difficulties by providing a discharge pipe to carry the water downward out of the cab and is of a sufficient size to prevent any possibility of the heavy glass in the shield being broken when the tubular glass bursts.

Larger Locomotive Cylinders

A 24 in. diameter cylinder requires a mean effective pressure equal to about 84 per cent. of that required by a 22 in. diameter cylinder when giving the same horse power at the same speed. A 23 in. diameter cylinder requires 92 per cent. of the mean effective pressure of the 22 in. diameter cylinder for the same horse power. In other words, a locomotive having 24 in. diameter cylinders will deliver the same horse power or tractive effort with a considerably shorter cut-off than the 22 in. diameter cylinder provided the port areas are of sufficient size to keep up the admission pressure equally well in both cases. Economy in steam consumption on the basis of pounds of steam per indicated horse power per hour, will increase proportionally to the point of cut-off, other things being equal. The shorter the cut-off the greater the economy. When using saturated steam a larger cylinder than actually necessary for the power is not advisable, as the increase in the condensing effect from its larger surface will largely overcome the gain made by the shorter cut-off and the longer expansion. On the other hand, with superheated steam this difficulty does not appear and there is no objection to using the larger cylinders if the clearance and weight limits will permit it. It has been found that with low speeds at very long cut-off there is no gain by superheating, and the indications are that the value of superheated steam increases with the shortening of the cut-off, although probably not at the same rate. All of these conditions point toward the advantage of using larger cylinders than have been considered proper heretofore. Another feature that should not be overlooked is the fact that less steam per stroke may permit the use of a smaller valve, and a smaller valve usually means a lighter one. An objection that immediately arises to the suggestion of increasing the size of the cylinders is the fact that it will make the engine slip more easily at starting, and this of course is true. Slipping, however, depends on both the admission pressure and the point of cut-off in the cylinder, and any troubles of this kind may be easily overcome by a partial opening of the throttle, thus reducing the admission pressure, or by shortening the cut-off somewhat. The former is probably the better practice. In starting an amount of power less than that required to slip the drivers must be used, and this power may be obtained as well from a large cylinder as from a smaller one.

Lake Shore Mikados

The new 2-8-2 type locomotives for the Lake Shore & Michigan Southern are interesting, not so much because of their very large size, as they have been nearly equaled in this respect by several previous designs, nor on account of their great power, as they are exceeded in this particular by others already in operation; but because of the design and arrangement of various detail features. For instance, vanadium alloy steel is used to a larger extent on this locomotive than any previous one with the possible exception of No. 50,000. It has been specified after a fairly long period of experiment with the material, and the indications are that steel alloyed with vanadium is proving all that its champions expected. In this case it is used for the frames, axles, main rods, springs, piston rods and in the cylinders of all the locomotives, in addition to the valve motion parts of ten of them. There is, however, no apparent reduction of section or weight on any of these parts with the exception of the axles where, it is claimed, three of them are from ¾ in. to 1 in. less in diameter than would have been required with a heat treated carbon steel of the ordinary quality.

Very long driving boxes have been applied on the main axles for the first time in a locomotive of this type. Boxes of this kind have been experimentally used on a few very heavy passenger locomotives with considerable success. The main driving box of a locomotive wears much faster than the others and it has been found in the cases of passenger locomotives, at least, that these long boxes will about equalize the wear of all of the boxes on the locomotive. Causes that lead to increased wear also imply increased friction and a remedy for the former will also probably result in considerable decrease in the tendency toward heating with this box. A novelty is noted at this point in connection with carrying projections from the frame braces around the inside of the faces of the pedestal jaws and forming the seat for the shoes and wedges entirely on these extensions instead of half on the frame and half on the brace as has been the practice with the previous boxes of this width. From a maintenance standpoint the arrangement of the whole design at the main journals can excite but favorable comment.

An auxiliary lubricator which insures a positive and increased supply of oil to the cylinders when the throttle is open, an efficient shield around the water glass, permanent and rigid fastenings for the various pipes, and an arrangement whereby the fireman's hose for sprinkling down the coal is provided with cold water from the tank instead of hot water from the boiler, are among the other details that add to the interest in this design.

Steel Passenger Cars

While the steel passenger car expert can properly object that there was comparatively little of value to him in the thirteen papers presented at the Railway Session of the American Society of Mechanical Engineers on April 8; to railway motive power department men in general, as well as to the layman, there were matters of great interest and value brought out in this discussion. Summing up the meeting as a whole, the evidence is clear that, in the minds of the experts who prepared the papers, the all-steel passenger car is the preferable construction. A small amount of natural or artificial wood can be permitted on the interior finish, but the underframe, superstructure framing, exterior sheathing and moldings should be of steel. There were no definite recommendations made as to the value of the all center sill or the all side supported car. Advocates of both designs were heard, and it appears that both are in successful use. There was, however, a uniformity of opinion in favor of a very heavy and strong end construction for the body of the car. One of the speakers advocated, and described at some length, a design of vestibule which is built somewhat weaker than the car body structure, and is arranged to collapse in the case of a severe collision shock. The contention is that, in its destruction, it will absorb the momentum of the train and reduce the effect of the shock on the passengers, and, at the same time, protect the car body from damage. No objection was raised to this suggestion, although it is but fair to state, there was but little time given for the discussion of the papers. Those who care to present their views on any phase of the subject may submit them in writing and they will be published in the journal of the society. Another recommendation that was allowed to go

by default, because of lack of time for discussion, was that six-wheel truck frames should be of the built up, wrought steel design.

Possibly the paper that aroused the greatest amount of interest was the one by C. D. Young, on the painting of steel passengers cars, in which he described the method that has been in experimental use at the Altoona shops of the Pnnsylvania, wherein the complete car is placed in an over and subjected to a high temperature after receiving each coat of paint. This rapidly dries the paint and reduces the amount of time required for painting a steel passenger car by about ten days. When used in connection with a suitable mixture of paint and varnish, it is believed that this practice will produce a much more durable wearing surface on both the interior and exterior of the car. A liberal extract of this paper, including a description of the oven and the schedule for applying the different coats of paint to the car, is found on page 245 of this issue. On the Hudson & Manhattan Railway, where the cars are subjected to extreme ranges of temperature due to their combination surface and tunnel operation, a method of artificially drying the finish on the interior of the car by means of electric heating has been very successful. Approximately the same temperatures and methods are used as on the Pennsylvania, but as it is not necessary to maintain the same high and durable finish on the exterior that is required for steam railway practices, no special oven is employed. Special paint formulas had also to be developed by this company for this work.

Saving Time in the Drawing Office

While the waste of time and the consequent waste of money on railroads is not so great as some of the efficiency men would have us believe, there are a great many points where savings could be made by more careful planning and assigning of the work. For example, in the drawing office, there are many assignments to be made, some of them relating to work that is of great importance and requiring the thought and labor of possibly months; while others, although they may be of prime importance, require only a few hours or, at most, a few days to complete. If the man in charge of the drawing office familiarizes himself with the general run of work to be handled, he can develop a plan of assignment that will permit of a minimum of time being lost in shifting from one job to another.

This is a matter that needs more consideration in many drawing offices. It is not uncommon to find a draftsman who has an important piece of designing in hand, called upon to do some minor work every few days. This breaks in on his calculations and on his trend of thought; he loses time in changing to the new work and in changing back again and finding just where he left off. As long as railroad requirements remain what they are, it will not be possible to eliminate such losses entirely. There will always be times when the general manager or the superintendent of motive power wants some piece of information in a hurry and it will be necessary to break in on the work of some man or men; in some cases it is even necessary to take the whole office force off their assignments and put them on special work that is of the utmost importance to the company. There is, however, an opportunity, by the careful study and selection of the men who are employed and by a study of the class and quantity of the work passing through the office, to reduce these interruptions of the office routine to a minimum.

It is difficult to apply a hard and fast rule to every case; indeed, it is doubtful if such a thing is possible, but a method that has given considerable satisfaction in at least one case is that of assigning the jobs which are likely to require considerable time, as well as mature judgment, to a selected number of men, leaving the smaller or what might be termed transient work to the younger and less experienced ones. By following this plan it is possible, to a large extent, to eliminate the interruption of the more important work, as, if some rush order comes in it can generally be handled by one of the minor draftsmen whose work will be least disturbed by the interruption. The important feature of this method is that while it provides, among the minor draftsmen, for the necessary flexibility in the office force, it permits of the older men going on with their more important work, completing it and getting other assignments, instead of having a design or a set of calculations hanging fire, partly completed, for months, while a file of correspondence accumulates containing, for the most part, excuses and explanations for the non-completion of the work. Most drawing offices are under-manned, which, in itself, tends against efficiency, and the higher officers should be brought to realize that an adequate payroll can be made to more than offset itself and that their part in such an efficiency program is the providing of the funds necessary to secure enough men of the right character.

A cause which contributes freely toward the waste of time, not only on the part of the draftsmen, but those above them, is the inability of a great many railroad employees to make an intelligent report. Very commonly, if a draftsman is instructed to make an investigation and prepare a report on his findings, he hands in a document which, if any information is to be obtained from it, requires long study and remaking on the part of the higher officer. It is quite possible that the chief draftsman or the mechanical engineer may wish to discuss the matter at issue over the telephone with some one else; there may be considerable at issue, with the possibility of a large expenditure of money involved. In such a case the man who is discussing the report needs the information where it is instantly available for the answering of any question that may arise. What he wants is a plain, intelligent report, arranged logically and as briefly as clearness will permit; what he gets, nine times out of ten, is a jumble of words, probably not even paragraphed, with some points that amount to little enlarged upon several times, and others of great importance given almost no attention. If the matter under consideration can be covered in a report of a few words, it should be done; the most important points should be emphasized, but above all there should be a sequence and logical order to the sentences. If, for example, a report on a locomotive is being prepared it is not logical to deal with the axles in one sentence and with the throttle valve in the next, yet things as inconsistent as this are by no means uncommon.

Too much stress may be laid upon brevity, which while very desirable, should not be permitted to affect the clearness of the report. There are frequently matters which cannot be dealt with in report form without going to considerable length, and in such cases a summary may often be used to advantage. This summary should deal briefly with the more important conclusions and refer, when possible, to the specific items in the detailed report; but even when it is necessary in preparing a report, to go to considerable length, logical order and conciseness should not be lost sight of.

While the making of reports has been referred to here only in connection with the drawing office, the same considerations apply anywhere in the mechanical department. The road foreman of engines and the engine house foreman in making reports to the master mechanic, the master mechanic in reporting to the superintendent of motive power, and the latter reporting to the general manager, should all endeavor to so shape their reports that they will save their own time and that of their superiors, for a poorly constructed report is quite likely to react on the maker by being sent back for reconsideration and reconstruction. This is a subject which should be given serious attention in apprentice schools; but those men who have not the opportunity of attending such schools may improve and broaden themselves greatly by reading and self-education, keeping always in mind that what is required is brevity, consistent with clearness.

Modern Locomotive Practice

Lawford H. Fry recently presented a paper before the Institution of Locomotive Engineers in London, in which he analyzed the general features and principal dimensions of typical modern locomotives in the United States and Europe for the purpose of obtaining an idea of the general trend of locomotive practice at the beginning of the present year. The locomotives selected include examples of the latest designs from fourteen American, twelve British, four French, three German, one Italian and one Belgian railway. The European roads selected have about 64,000 miles of track and about 60,000 locomotives, while the American roads have about 57,000 miles of track and about 15,000 locomotives. The examples of freight locomotives range in total weight from 100,000 lbs. for the North British 0-6-0 type, to 540,000 lbs. for the Virginian 2-8-8-2 type. Between these extremes the other locomotives fall more or less clearly in three groups according to the nationality. At the lighter end are the British, and at the heavier end the American, while the continental engines take intermediate positions. Mr. Fry states that the average American freight locomotive is about twice as heavy as the average British, while the heaviest American is over three times the weight of the heaviest British. He points out that this condition is not because of undue conservatism on the one side, or the tendency to exaggeration on the other, but that it is legitimately produced by the difference in the conditions of the traffic in the two countries. In Great Britain there are about 1,800 inhabitants per mile of railway, while in the United States there are only about 450. From the longer hauls thus necessitated in this country, as well as because of the larger quantities of raw material to be handled, it follows that, while in England it is economical to provide an intensive service with a large number of trains of moderate weight, in the United States less frequent and more heavily loaded trains give more economical results. In this connection it is noted that in England there are 12.1 locomotives for each 10 miles of road, while in America there are only 2.7 locomotives for each 10 miles of road.

A study of the locomotive types in use in the various countries indicates that in Great Britain, while the lighter types, such as the 0-6-0 and the 0-8-0 in freight service and the 4-4-0 and the 4-4-2 type in passenger service, are still used, the 4-6-0 type is becoming more popular in passenger service as the demand for increased power becomes greater. In freight service the 2-6-0 type is being introduced on several railways. It thus appears that the tendency is toward the ten wheeler for passenger service and the mogul type for freight service, although tank engines have given excellent results on some lines. All but three of the British engines shown in a table included in the paper, were equipped with superheaters, and the indication is that an increasingly large number of new engines will be provided with superheaters. All the engines are single expansion, and it appears that the compound is hardly more than holding its own in Great Britain. In speaking of compounding, Mr. Fry said that although there are greater advantages in compounding with passenger than with freight engines, it appears that the determination as to whether the advantages or disadvantages are greater is largely a matter of nationality, the English and American believing the disadvantages to be most prominent, while the continental designers think otherwise. He is unable to see why four single-expansion cylinders should be used under any conditions.

In France, the freight service is being handled mainly by the 2-8-0 and the 2-10-0 types, and the passenger service by 4-6-2 type locomotives. Four-cylinder, compound engines are being maintained in spite of the introduction of superheaters. When superheat was first introduced there was a tendency to revert to single expansion, but the evidence is now clear that compounding is just as advantageous with superheat as with saturated steam.

The German locomotives selected are all of three railways, two being in South Germany and the Prussian State Railway in North Germany. The South German engines are all of the four-cylinder, compound, superheater design. The 2-8-0 type and the 0-10-0 type are used for freight service, and the 2-6-2 type and the 4-6-2 type for passenger service. The South German roads are alone in Europe in using bar frames of the American pattern. On the Prussian State Railways the 0-8-0 and the 0-10-0 type, two-cylinder, superheater locomotives are used for freight service, while the 4-4-0 and the 4-6-0 type are used for passenger service. For heavy, high speed, passenger service, superheater, 4-6-0 type locomotives, both simple and compound, have been employed. The results from the compound, however, have been so satisfactory that it is probable that the Prussian State Railway will return permanently to compound cylinders for the heaviest class of high speed locomotives.

In Italy the heaviest freight traffic is handled with 0-10-0 type locomotives, with four compound cylinders and saturated steam. In passenger service the trains do not operate at very high speeds and locomotives of the 2-6-2 type have given very satisfactory results. A Pacific type has been introduced but, for the present at least, this engine is more powerful than is necessary, and is so heavy that it cannot be used on all parts of the railway. Passenger engines in Italy are being fitted with superheaters and four cylinders, in most cases.

The conclusion for the United States indicates the 2-8-2 and the Mallet types for freight service and the 4-6-2 type for passenger service, to be the present tendency. It is pointed out that compounding is but little used and that superheating is being generally introduced, but not quite so widely as in Europe. In his general conclusion, Mr. Fry states that compounding shows a revival on roads where it has been dispossessed by the introduction of superheating, and while there is plenty of evidence that economy in coal can be effected by the double expansion of the steam, the engineer who decides to forego it for the sake of simplicity, will do so in very good company.

NEW BOOKS

Book of Standards. National Tube Company, Pittsburgh, Pa. 559 pages, 4 in. x 6½ in. Price, $2.

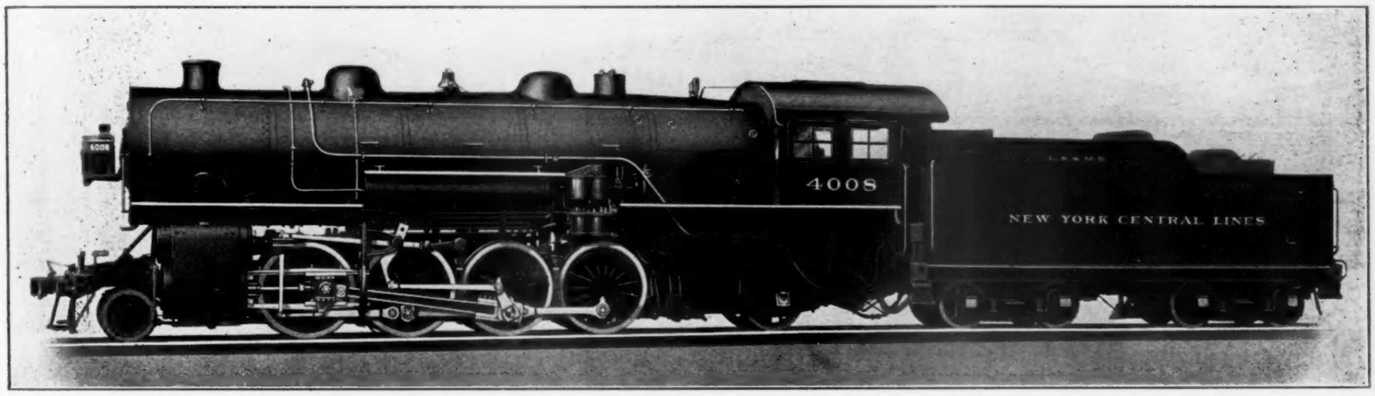
This book is strictly a pipe handbook, is printed on thin paper so that it is not quite ⅝ in. thick, and is a handy size for pocket use. Several pages are devoted to a descriptive article covering the main process of manufacturing both welded and seamless tubes. There are a number of pages which give weights, dimensions, threads per inch, test pressures, sections of joints, specifications, etc., of the various kinds of pipes and tubings. Several pages describe, illustrate and contain tables in regard to lap-weld and seamless tubes, upset and expanded, wrought pipe bends, butted and strapped joints, etc. Considerable prominence is given to strength of tubes and cylinders under internal fluid pressure and collapsing pressures. Considerable attention is devoted to the mechanical properties of solid and tubular beams, of usual and unusual shapes. Chapters are included giving information in regard to water, gas, steam and air. It has not been the intention to go very deeply into these various subjects, only in so-far as they concern tubular products. There is a large collection of tables, such as fifth roots and fifth power, decimals of a foot for each 1/64 of an inch, etc. Several pages are devoted to area and weight factors for tubes and pipes. A table showing properties of tubes and round bars is given with an explanatory article. The Metric system is included with conversion methods for most of the more commonly used measures, including temperatures. A table of wire and sheet metal gages as adopted by the Association of American Steel Manufacturers is given. A glossary of terms used in the pipe and fittings trade will also be found.

LARGE MIKADOS FOR THE LAKE SHORE

Heaviest Locomotives of Their Type Replace Powerful Consolidations with Decided Economy.

The heavier class of freight service on the Lake Shore & Michigan Southern is very largely handled by consolidation type locomotives. These are equipped with superheaters and are among the heaviest and most powerful of their type in this country. Traffic conditions on many parts of the Lake Shore seem to be well adapted for developing the advantages of the Mikado type locomotive to the fullest extent. This is proved by the service of twenty 2-8-2 type locomotives of the largest size which this company has recently received from the American Locomotive Company. Although the tractive effort has been increased but 22½ per cent., as compared with the consolidation type of locomotive used, the tonnage rating for main line work gives the new Mikados 4,300 lbs., while the superheater consolidation locomotives are rated at 3,200 tons. This is an increase of nearly 35 per cent.

The new engines are the heaviest of their type on our records, having a total weight of 322,000 lbs., and represent the latest practice in design in every particular, although they have no new or untried general features. With a steam pressure of 190 lbs. the tractive effort is 56,000 lbs. This is 4,800 lbs. less than the Chesapeake & Ohio Mikados, illustrated on page 128 of the March issue of this journal, which are the most powerful of their type. The Lake Shore engines have a reasonably high factor of adhesion, the ratio being 4.37 as compared with 4.00 on the Chesapeake & Ohio engine. It is the practice of this company to use a fairly high ratio of weight on drivers to tractive effort, for the purpose of giving ample adhesion when the tires have been worn nearly to the limit. The importance of this feature will be readily understood when it is considered that if the tires are worn 2 in., thus reducing the diameter of the wheels by 4 in., and if at the same time the cylinders have increased ½ in. in diameter, the tractive effort will be raised to nearly 62,000 lbs. This reduces the factor of adhesion from 4.37 to 3.95. Although these engines are being operated with 190 lbs. steam pressure, they are designed for a pressure of 200 lbs., so that a tractive effort can be increased to 59,000 lbs. if desired.

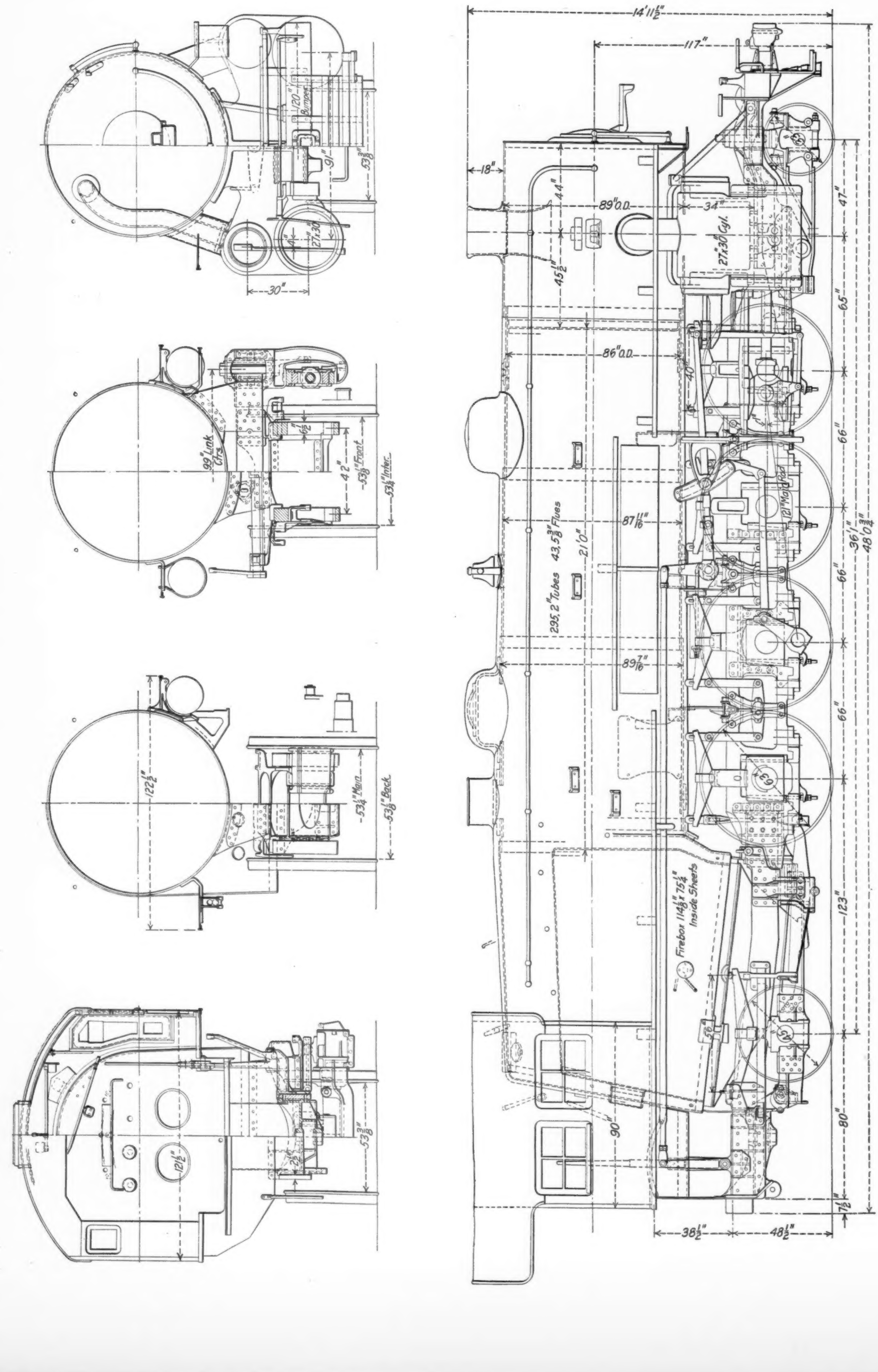


Heaviest Mikado Type Locomotive; Lake Shore & Michigan Southern.

An idea of the power of these locomotives can probably best be obtained from a knowledge of the trains they are hauling on the road. A profile of the section between Carson and Coalburg, Ohio, is shown in one of the illustrations. The maximum grade for the direction in which the test runs were made is 16 ft. to the mile. The average train for three runs over this section contained 100 cars having a tonnage of 6,345 tons and was hauled at an average speed, excluding delays, of 14.58 miles per hour. These, of course, are test runs, but a comparison of the tonnage rating of these locomotives and the consolidations in regular service over various divisions, shows what they are doing in every day work. The consolidations with which they are to be compared have a total weight of 239,500 lbs., of which 214,400 lbs. is on drivers. The tractive effort is 45,800 lbs., the cylinders are 25 in. x 32 in., steam pressure 200 lbs. and the drivers 63 in. in diameter. They are equipped with superheaters having about 600 sq. ft. of superheating surface and the evaporating heating surface of the boiler is 3,023.1 sq. ft. On the eastern division out of Collinwood, the consolidations have a tonnage rating of 3,200 tons, while the Mikados are given 4,300 tons. Out of Seneca, the consolidations have a rating of 2,600 tons, while the Mikados are given 3,500 tons. On the Franklin division, out of Youngstown, the consolidations are given 3,400 tons and the Mikados 4,300 tons, while on the Toledo division the consolidations have 3,000 tons and the Mikados 3,500 tons.

In addition to the increase in power which would be expected with a larger engine, there has also been a notable economy of coal and water. Records taken from the Eastern and Michigan divisions give a somewhat unfair comparison which, however, indicates what may be expected under ordinary operating conditions. The average for three trips of a superheater consolidation locomotive having a total weight of 241,000 lbs. shows that it burns 15.9 tons of coal per trip of about 130 miles when hauling a 60-car train of 2,335 tons. This gives 8.17 miles per ton of coal, or 19,100 ton-miles per ton of coal. The average of three trips over the same division with a Mikado is 12.85 tons of coal when hauling a train that averaged 70 cars of 3,203 tons. This is 10.1 miles per ton of coal and 32,400 ton-miles per ton of coal. Although the figures for the Mikado are favorably affected by the cars in the train being more heavily loaded, still the conditions are normal to ordinary operation.

The difference between an increased hauling power of from 35 to 40 per cent. and an increased tractive effort of 22½ per cent. can only be attributed to the increased boiler capacity. If the equivalent heating surface (evaporating heating surface plus 1½ times the superheater heating surface) is taken for the two locomotives under comparison, and the same rate of evaporation is assumed for each, it will be seen that the Mikado is well over 50 per cent. more powerful as a steam maker than the consolidation. This indicates that to make as good a record as it did, the consolidation had to evaporate at a considerably higher rate per square foot of heating surface in these tests. If a comparison is made on the basis of theoretical maximum horsepower delivered with 700 ft. per minute piston speed, it will be seen that the Mikado is about 40 per cent. more powerful than the consolidation and, when operating under these theoretical conditions, it



Very Heavy and Powerful 2-8-2 Type Locomotive for the Lake Shore & Michigan Southern.

will evaporate about 5 per cent. less per square foot of evaporative heating surface.

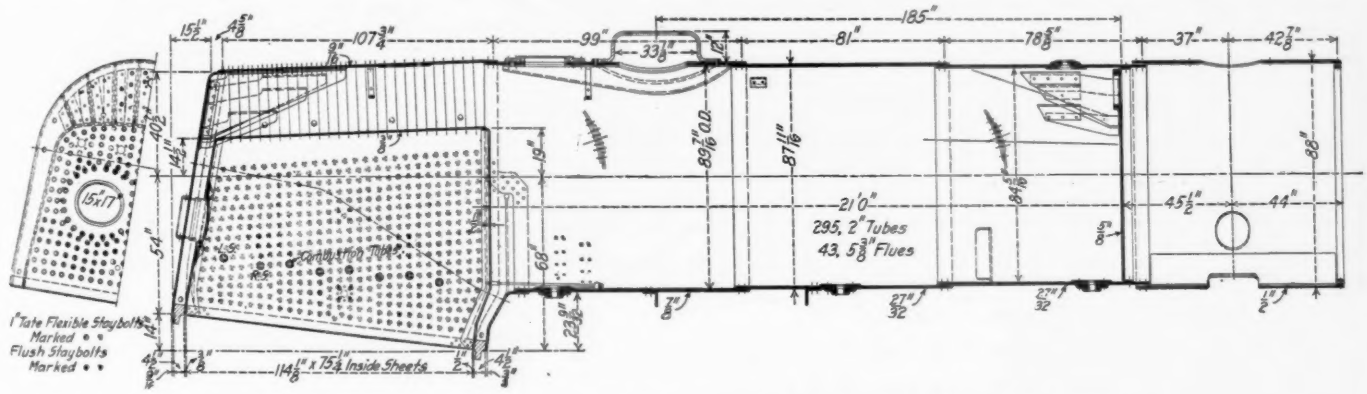
In the following table an opportunity is given for comparing this design with other large Mikado locomotives of recent design.

Road.	L. S. & M. S.	C. & O.	C. R. I. & P.	C. B. & Q.
Total weight, lbs.	322,000	315,000	318,850	303,400
Weight on drivers, lbs.	245,100	243,000	243,200	231,000
Per cent. weight on drivers	76.2	77.1	76.3	76.4
Tractive effort, lbs.	56,050	60,800	57,100	60,000
Factor of adhesion	4.37	4.00	4.26	3.85
Average weight per driving axle, lbs.	61,250	60,750	60,800	57,750
Cylinders, diameter and stroke, in.	27 x 30	29 x 28	28 x 30	28 x 32
Diameter of drivers, in.	63	56	63	64
Steam pressure, lbs.	190	170	180	180
Heating surface, evaporating, sq. ft.	4,730	4,051	4,264	4,627
Heating surface, superheater, sq. ft.	1,065	845	848	961
Ratio evap. to super. heat. surface	4.4	4.8	5.03	4.82
Equivalent heating surface, sq. ft.	6,328	5,319	5,536	6,069
Maximum theoretical horsepower*	2,610	2,500	2,470	2,470
Evaporation per sq. ft. heating surface†	11.60	12.95	12.15	11.20

*Taken at 700 ft. piston speed and 62 per cent. maximum tractive effort.
†Evaporating surface only, 21 lbs. of water per horsepower hour assumed.

cator valve, Franklin pneumatic fire doors, feed water connections, cold water sprinklers, and radial buffers, a special design of pipe clamp, a new water glass shield, and very long main driving boxes.

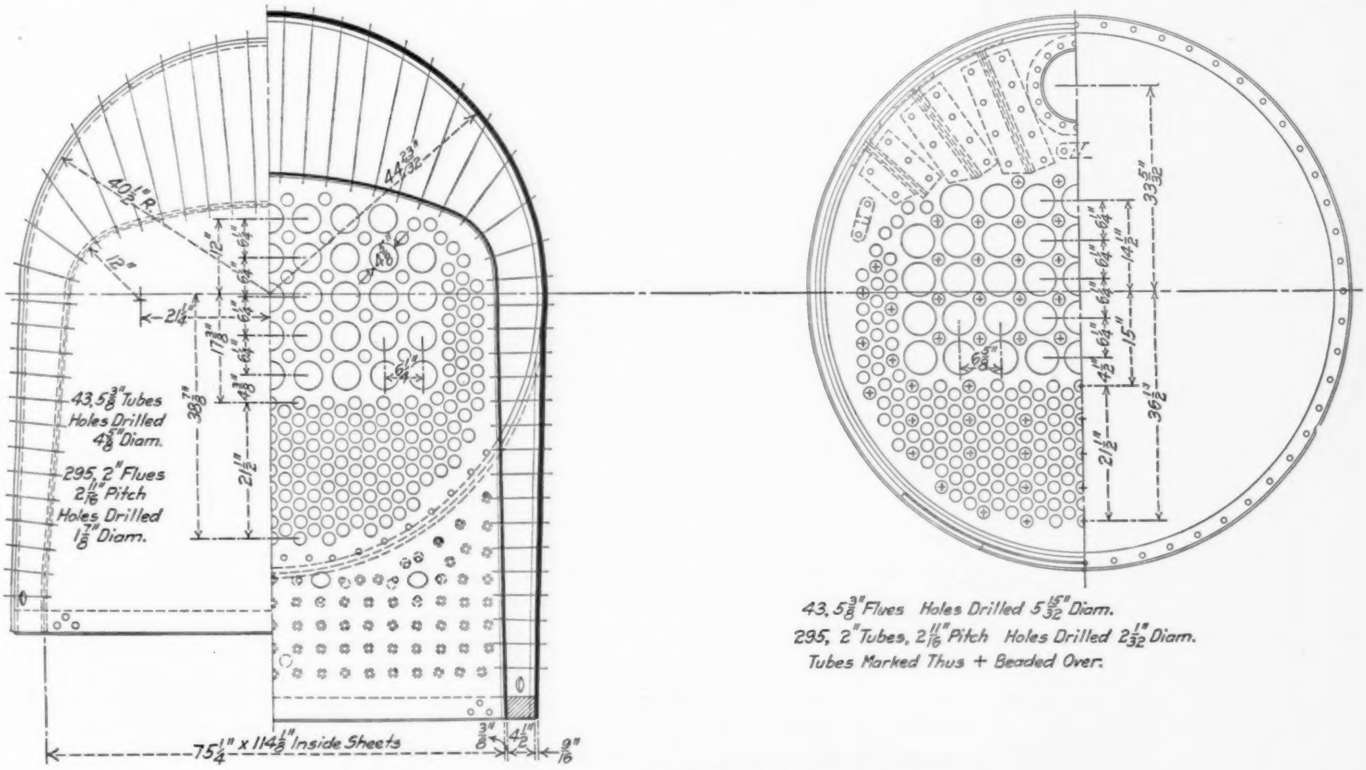
An interesting feature of the design is the extensive use of vanadium steel and iron for various parts. This material is used for the main frame, driving springs, piston rods, main and side rods, driving axles, trailer springs and main rod straps, as well as for the links, link blocks, pins and bushings in the motion



Straight Top Boiler Without Combustion Chamber; Lake Shore 2-8-2 Type Locomotive.

work of ten of the locomotives. The cylinders are also made of cast iron with a vanadium content.

Reference to the illustration and table of dimensions will show the features of the very large boiler which has been applied. It will be noticed that this design differs from customary practice in but few particulars. The firebox is of a normal radial stay arrangement, with two fire doors and does not include a combustion chamber. Two inch tubes, 21 ft. in length, are employed

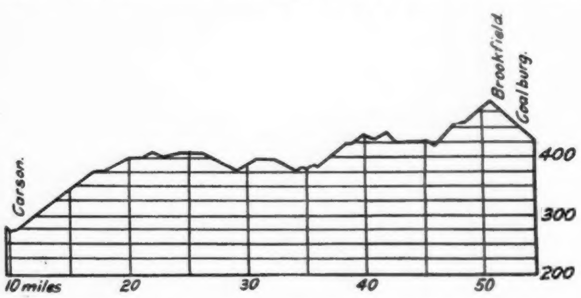


Sections of the Firebox and Boiler; Lake Shore Mikados.

In general features of construction the design is normal and is thoroughly modern in every particular. A number of new features of a minor, but important, nature have been included, some of them being used on this locomotive for the first time. Among these might be mentioned the MacBain auxiliary lubri-

and are distributed in the normal manner. The superheater elements are included in forty-three 5⅜ in. superheater flues. An improvement, which is now being applied to a number of the more recent locomotive boilers, is an inspection manhole, 16¼ in. in diameter, located just back of the dome and about 2 ft. ahead of

the back tube sheet. The ¾ in. liner that stiffens the opening around the dome is carried back to include this opening as well. The cover plate of the inspection manhole carries the safety valve and it takes the place of the auxiliary dome which has often been installed at this point. The stringent requirements of the boiler inspection law make it necessary to frequently enter the interior of the boiler and since, when this is done through



Profile of Line from Carson to Coalburg, Ohio.

the ordinary dome, it requires the removal of the throttle stand pipe, this auxiliary manhole is an improvement that is welcomed by the inspector.

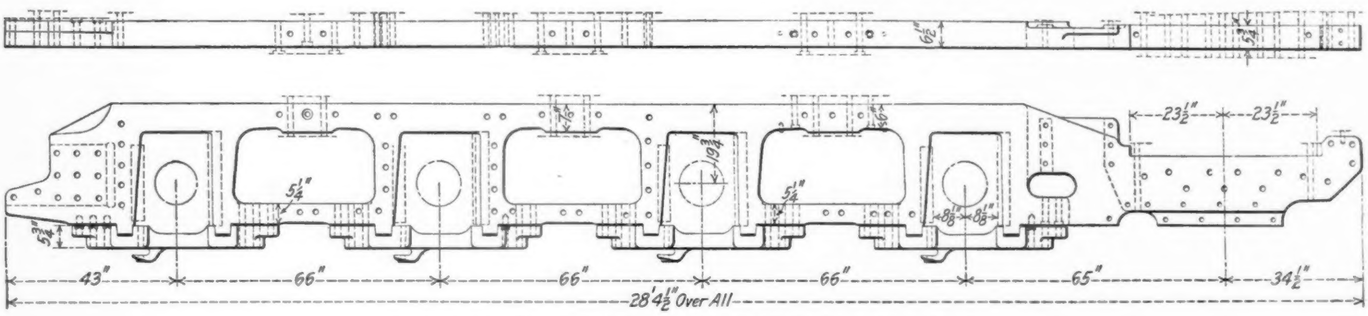
Five of the engines are equipped with the O'Connor type of fire door flange and all have a full installation of flexible staybolts with the exception of six longitudinal rows of button head radial stays at the top of the crown sheet. There are four 2 in. combustion tubes placed in each side water leg. These permit air to enter the firebox over the top of the fuel bed and thus

in thickness which fits snugly to the inner faces of the jaws. The very wide shoes and wedges are fitted to these crosstie extensions and have an increased bearing surface of about 350 sq. in. over what they would have if they were applied to the frames only. The pedestal binder is also of extra width and a second wedge bolt is provided for handling the wide and heavy wedge.

The main journals are 11½ in. x 22 in. and the driving box is quite similar to the one used on the Delaware Lackawanna & Western Pacific type locomotive, which was illustrated and described on page 391 of the August, 1912, issue of this journal. Driving boxes of this type have been in experimental service on the New York Central Lines for some time, particularly on passenger locomotives, and have given most satisfactory results.

A somewhat unusual method of equalization has been employed. It has been found that on locomotives of the Mikado type where the first two driving wheels and the engine truck are equalized together, the springs are difficult to maintain in a level position. For this reason it was decided not to carry the forward unit back of the first pair of drivers in this case and the engine is equalized with the forward pair of drivers and the front truck forming one unit and the last three pairs of drivers and the trailing truck forming the other units on each side in the usual manner.

By the use of vanadium steel the front, rear and intermediate axles have been reduced to 9¾ in. in diameter between the journals, which are 11 in. x 12 in. This is ¾ in. less, in the case of the front and intermediate axles, and 1 in. less in the case of the rear axles, than common practice would require for carbon steel axles with journals of the above size on locomotives of this type.

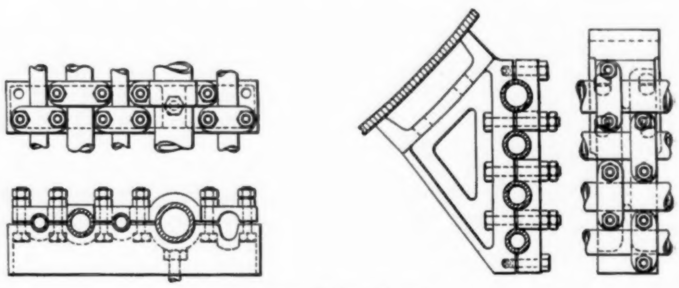


Main Frames for Lake Shore 2-8-2 Type Locomotive.

promote combustion. The throttle rod is carried by two V-shaped supports swung from the top of the boiler and is held at the bottom of the V by a pin extending through the supports just above it. This attachment prevents the rod from buckling and therefore practically eliminates the lost motion of the throttle lever when the throttle is tightly closed. The back head and front tube sheet are both stayed with ½ in. boiler steel gusset plates which are riveted to 4 in. x 4 in. angles on both the heads and the shell.

Vanadium cast steel frames 6½ in. in width and 7 in. deep over pedestals are used. The rear frames are in the form of a slab 3½ in. in width and 15 in. deep, which is spliced to the main frame just back of the rear pair of driving wheels. Care has been given to provide ample strength at the points of possible failure. In addition to using the best material of ample section in the main frame, the frame bracing has also been given considerable attention. This is noted particularly in connection with the design of the lugs on the frame braces where the frame bolts pass through. A bearing area for the bolts is provided that will develop practically their full shearing strength. There are vertical frame braces or crossties applied on the rear pedestal jaws of the last three pairs of drivers and to the forward jaws of the main drivers as well. The construction at the main pedestal is of particular interest in connection with the arrangement for the application of the very long driving boxes that are used. The vertical frame crossties on both sides of this pedestal are continued through to the outside of the frame by a projection 1 in.

Vanadium cast iron is used in the cylinders, which are cast integral with the saddles and are interchangeable, right and left. Both the cylinders and valves are bushed with Hunt-Spiller gun iron and the piston and valve packing rings and the crosshead shoes are made of the same material. The diameter of the valve and the valve setting are shown in the table of dimensions at the end of this article. The valve gear is designed to give a

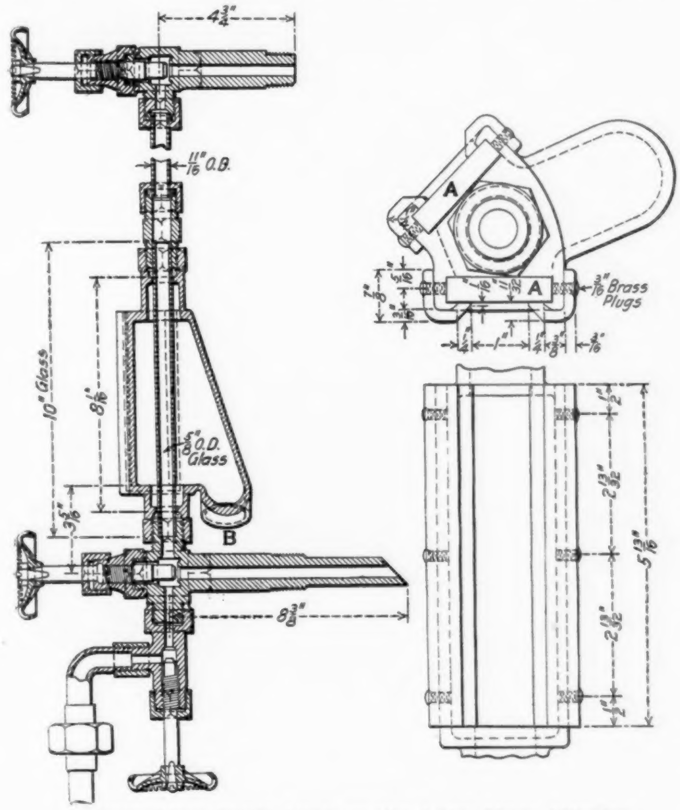

Ayers Pipe Clamp.

cut-off of 88 per cent. in full gear in order to secure the maximum tractive effort in starting.

These locomotives are equipped with an arrangement for forcing the oil through the feed pipes when the throttle is open, that was designed by D. R. MacBain, superintendent of motive power. It employs a valve that is held seated by a spring and is so located and arranged that its extending stem will be forced in-

ward by an extension on the throttle lever when the latter is open. This unseats the valve and allows a passage for steam directly from the boiler to the oil pipes leading from the lubricator to each cylinder. Its arrangement and operation is clearly shown in the illustration. It insures the proper lubrication of both cylinders as soon as the throttle is open, but when the latter is closed the lubricator will feed in the ordinary way only.

A feature that is ordinarily given but scant attention has in this case been given the study it really deserves. This refers to the arrangement and clamping of the various pipes. Special designs of clamps have been prepared by A. R. Ayers, general mechanical engineer of the New York Central Lines west of Buffalo, which not only holds them firmly in place but provides a separate clamp for each pipe so that one may be removed without disturbing the others. The arrangement is most substantial and the pipes will not be subjected to the vibration which so often leads to failure at the joints. Furthermore, the pipe fitters have a definite alignment to work to, as the piping is laid out in the drawing room, and each pipe is in a definite place and can

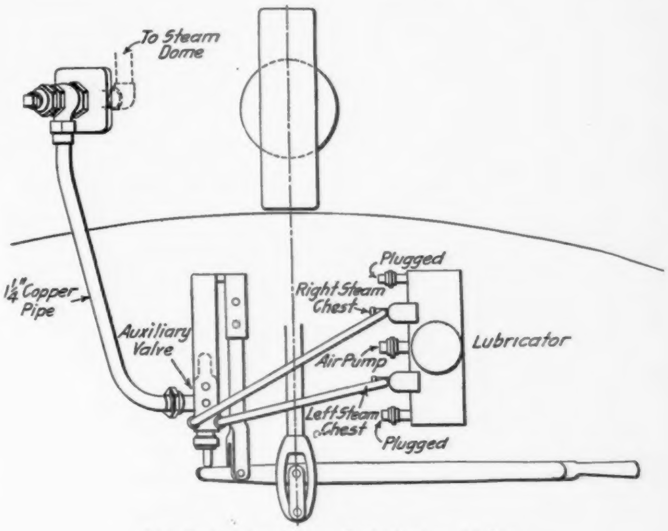


Water Glass Shield Used on the Lake Shore Mikados.

only be attached in that place. This not only makes the work much easier for the pipe fitters, but prevents them doing their work in a haphazard manner. In connection with the pipe clamp, a slot has been provided for the cylinder cock reach rod. This rod extends back from the cylinders to a rocker under the cab running board and the lever is placed just inside the cab within easy reach of the engineer who may operate it by hand instead of kicking it open and closed with his foot.

Another interesting device that has been applied to this locomotive and is here illustrated is a design of water glass shield which has recently been made standard on this road. This shield completely encloses the water glass, the only outlet being at the point marked B in the illustration, from which a pipe leads downward through the floor of the cab. There are two glass plates marked A, which are 1 13-16 in. x 6 in. x 13-32 in. and are set at an angle of 45 degrees to each other in the shield. This shield completely protects the water glass from danger of accident by external means and also prevents any accidents in case the glass should break of itself, as the steam and water will pass down through the outlet pipe to the outside of the cab and there will be no opportunity for small pieces of glass to fly. As will be seen, it offers no obstruction to the ready application of a new glass when necessary.

The tender is fitted with the railroad's standard 7,500 gal., 12-ton, water bottom tank which is carried on a Commonwealth cast steel frame. Commonwealth cast steel trucks are employed and the tender has a standard water scoop.



MacBain Auxiliary Lubricator Valve.

General dimensions, weights and ratios of these locomotives are shown in the following table:

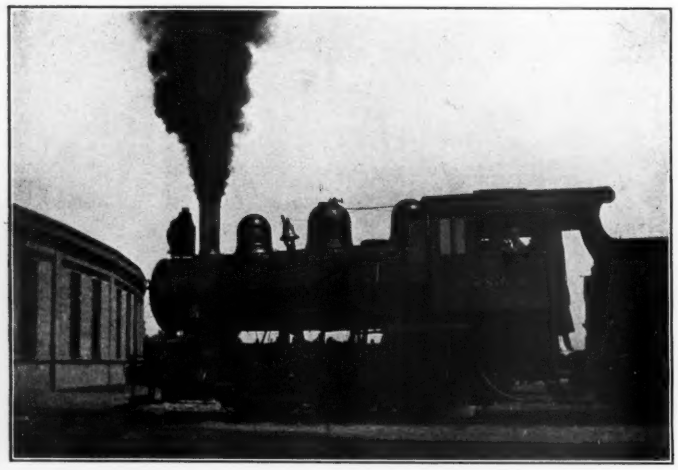
General Data.	
Tractive effort	56,050 lbs.
Weight in working order	322,000 lbs.
Weight on drivers	245,000 lbs.
Weight on leading truck	27,500 lbs.
Weight on trailing truck	49,500 lbs.
Weight of engine and tender in working order	477,800 lbs.
Wheel base, driving	16 ft. 6 in.
Wheel base, engine and tender	68 ft. 10½ in.
Ratios.	
Weight on drivers ÷ tractive effort	4.37
Total weight ÷ tractive effort	5.72
Tractive effort x diam. drivers ÷ evaporating heating surface	746.00
Evaporating heating surface ÷ grate area	79.50
Firebox heating surface ÷ total heating surface, per cent	5.20
Weight on drivers ÷ total evaporating heating surface	51.70
Total weight ÷ total evaporating heating surface	68.00
Volume both cylinders, cu. ft	19.86
Total evaporating heating surface ÷ vol. cylinders	239.00
Grate area ÷ vol. cylinders	3.00
Cylinders.	
Kind	Simple
Diameter and stroke	27 in. x 30 in.
Valves.	
Kind	Piston
Diameter	16 in.
Greatest travel	7 in.
Outside lap	1 in.
Inside clearance	0 in.
Lead	⅛ in.
Wheels.	
Driving, diameter over tires	63 in.
Driving journals, main, diameter and length	11½ x 22 in.
Driving journals, others, diameter and length	11 x 12 in.
Engine truck wheels, diameter	33 in.
Engine truck journals	6 x 12 in.
Trailing truck wheels, diameter	45 in.
Trailing truck journals	8 x 14 in.
Boiler.	
Working pressure	190 lbs.
Outside diameter of first ring	86 in.
Firebox, length and width	114⅛ x 75¼ in.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	4½ in.
Tubes, number and outside diameter	295 2 in.
Flues, number and outside diameter	43 5⅜ in.
Tubes and flues, length	21 ft.
Heating surface, tubes	4,494 sq. ft.
Heating surface, firebox	246 sq. ft.
Heating surface, total evaporating	4,730 sq. ft.
Superheater heating surface	1,065 sq. ft.
Grate area	59.6 sq. ft.
Smokestack, height above rail	14 ft. 11½ in.
Tender.	
Frame	Cast steel
Wheels, diameter	36 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	7,500 gals.
Coal capacity	12 tons.

TESTS OF SMOKE ABATEMENT DEVICES

The Chicago & North Western made a demonstration run Tuesday, April 15, for the benefit of various railway officials and press representatives from Chicago to Proviso, testing out a device for smoke abatement on locomotives recommended to the railways about Chicago by the General Managers' Association. Some months ago O. Monnett, smoke inspector for the city of Chicago, called the attention of the General Managers' Association to the fact that there were wide differences of opinion among the railroads as to the most efficient locomotive smoke preventing device—each road maintaining that the devices used by it were the best.

The General Managers' Association accordingly appointed a special committee consisting of representatives of the mechanical departments of the Pennsylvania, Chicago & North Western, Chicago, Burlington & Quincy, Chicago, Milwaukee & St. Paul, and the Chicago & Western Indiana Railways, which committee was asked to make comparative and efficiency tests of the several smoke preventing devices. Extensive tests were made on the Pennsylvania Railroad's testing plant at Altoona, the results of which will be presented before the Master Mechanics' Association at its June convention. In brief, it was found that either the double or multiple tip blower nozzles should be used; that the grate should have not less than 30 per cent. air opening; that sufficient air tubes should be provided above the fire, so that a total of 2,000 cu. ft. of air per minute could be supplied by means of steam jets, the nozzles of which should be located 8½ in. from the inside ends of the tubes; that the brick arch prevents more smoke while the locomotive is running than when standing, and that such an arch gives the best results when fitted tight up against the flue sheet; that there is advantage in a large quick-opening blower valve.

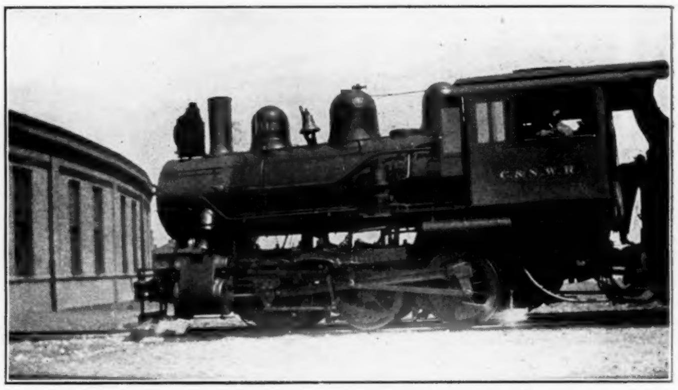
The test run was made with an 18 in. x 24 in. superheater 6-wheel switch engine equipped in accordance with the above recommendations. The trip out to Proviso was made with a train of about 1,000 tons gross, and the results obtained were



Without Smoke Abatement Devices in Use.

considered very satisfactory by all observers, there being practically no smoke thrown from the stack throughout the whole trip. On reaching Proviso some severe tests were made on the device. It was cut out of service and the engine was allowed to smoke as badly as possible, then when being put into service again it was found that the smoke could be eliminated in from five to seven seconds. On the return trip a trainload of over 1,200 tons was hauled, a part of the distance being up a grade of 32 ft. per mile, no objectionable smoke being emitted from the engine at any time. The smoke density to Proviso was 4.6 per cent., and from Proviso 4.3 per cent.

In addition to the above mentioned test committee the General Managers' Association appointed a standing committee consisting of M. K. Barnum (chairman), Illinois Central; H. T. Bentley, Chicago & North Western, and E. F. Jones, of the "Belt" Railway. This committee developed the plan for the "Railroad Smoke Inspectors' Association of Chicago," which was organized on January 2, 1913, for the purpose of bringing about the thorough interchange of ideas between the smoke inspectors employed by the various Chicago railroads, and to utilize the inspectors for the joint benefit of all lines by requiring them to report cases of emission of dense smoke, whether made by locomotives of their own company or by those of any other



Seven Seconds Later With Devices in Service.

railway coming under their notice, thus bringing about increased efficiency in this line of work.

This association holds a meeting every alternate Friday, and the co-operation secured in this manner has done much in the way of reducing smoke on the part of the railroads in this district. The number of smoke inspectors on Chicago railroads has been increased from 32 to 41, making the number of locomotives in daily operation in Chicago per inspector employed 40 as compared to 52 under the former practice. The chairman of the association is J. H. Lewis, chief smoke inspector of the Chicago, Burlington & Quincy, and the chairman of the executive committee is C. W. Corning, chief smoke inspector of the C. & N. W., with C. P. Burnalle, chief smoke inspector of the A. T. & S. F., as the secretary.

The railroad smoke conditions in Chicago today as compared to the smoke densities in other cities and towns where no smoke ordinance is in effect is as follows:

Nashville, Tenn.	30 per cent.	LaSalle	30 per cent.
East St. Louis	40 per cent.	Down town Chicago	6 per cent.
Peoria	30 per cent.		

In 1910 the smoke density of down town Chicago was 23 per cent., which figure represents the density for South Chicago today. Intermediate sections of the city show a density of 12 per cent., showing that the effort of supervision in the down town section has had the effect of reducing the smoke density to a point which was thought absolutely impossible two or three years ago.

PENSIONERS ON THE PENNSYLVANIA.—The number of pensioners who are more than 80 years of age on the Pennsylvania system is 296.

CLASSIFIED EQUIPMENT DEFECTS.—The following table gives the number of defects for 1,000 freight and passenger cars and locomotives inspected by the government inspectors during the fiscal year of 1912:

Couplers and parts	6.12	Hand brakes	10.12
Uncoupling mechanism	8.09	Footboards	.13
Air brakes	33.51	Pilot-beam sill steps	.06
Handholds	7.98	Handrails	.02
Height of couplers	1.09	Power brakes	.03
Steps	.97	Ash pans	.03
Ladders	.62		
Running boards	4.43	All classes	73.45

DISTRIBUTION OF POWER IN MALLETS

Valve Setting and Cylinder Ratios When the Weight on the Two Groups of Drivers Is Unequal.

BY PAUL WEEKS.*

In a Mallet compound locomotive where the high pressure cylinders drive a different number of wheels than the low pressure cylinders, the work of the whole locomotive instead of being equally distributed between the high and low pressure cylinders, as is usually the case, must be distributed in proportion to the adhesive weight on the drivers in each group. Such engines have been built and sufficient experiments made so that the problem of cylinder design can be intelligently discussed.

The questions that arise in approaching the subject are as follows: What valve arrangement will give a constant ratio of work at all speeds and cut-offs? What ratio of cylinders is necessary to give the desired ratio of work? What sizes of cylinders are necessary to give the best return from the adhesive weight of the whole locomotive?

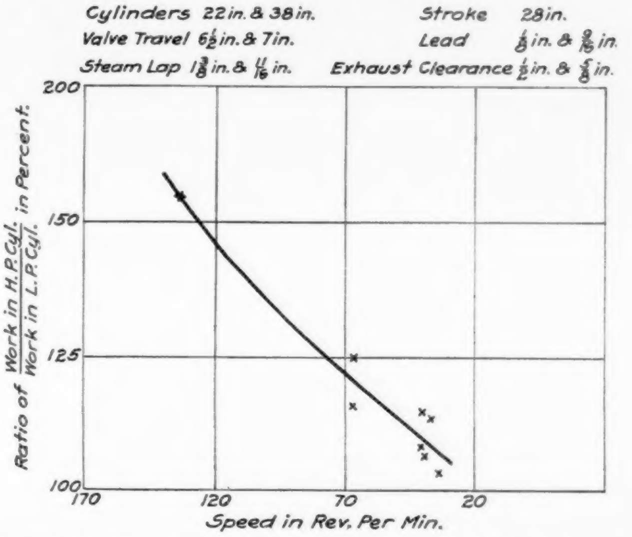


Fig. 1—Distribution of Power in the Locomotive at the Beginning of the Investigation.

In order to produce a steam distribution in the cylinders of a locomotive of this type on one of the western railways, such that each pair of cylinders would do work proportional to the weight on the drivers coupled to those cylinders, several arrangements of valve setting and cylinder ratios were tried. The high pressure cylinders in this case were connected to three pairs of drivers and the low pressure to but two pairs, making it necessary that the high pressure cylinders should do 1½ times as much work as the low pressure.

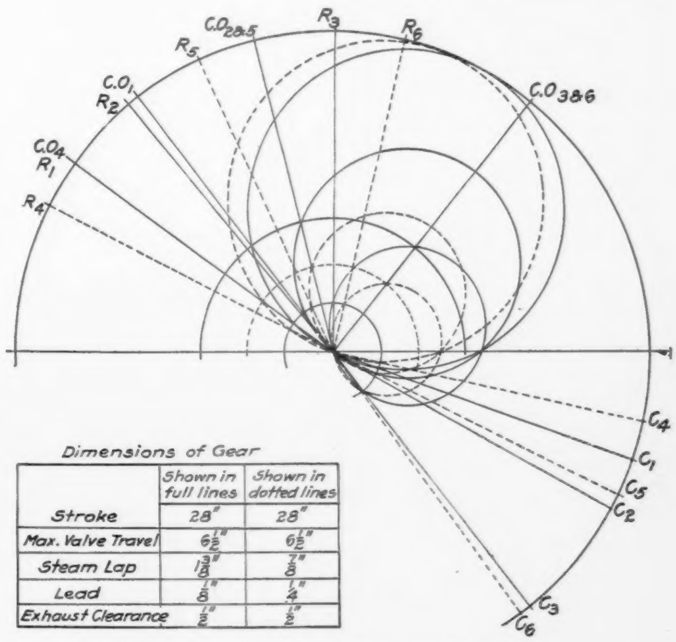
As the engines were sent from the builders the cylinders were 24 in. and 38 in. in diameter, and the valve gear was of the Walschaert type. The valves had a 1¼ in. steam lap and were set with a ¼ in. lead for the high pressure cylinders and 15/16 in. steam lap and 5/16 in. lead for the low pressure cylinders. It was found that this arrangement gave too much work in the low pressure cylinders. The result was that the front group of wheels continually slipped, this slipping even taking place before the full power of the high pressure cylinders could be exerted.

The valves were therefore changed to have 1⅜ in. steam lap and ⅛ in. lead for the high pressure and 11/16 in. steam lap and 9/16 in. lead in the low. Indicator cards taken with this arrangement showed an improvement in the work distribution, but at slow speeds the low pressure cylinders still did more than their share. It was noticed from these cards that the high pressure cylinders did a larger share of the work as the speed increased and the reverse lever was hooked up to give shorter cut-offs.

The next arrangement tried was to reduce the high pressure cylinder to 22 in. in diameter, leaving the low pressure cylinder and the valve setting on both the high and low the same as before. This gave a better work distribution than before, but the ratio of work in the high to that in the low was still too small when running at slow speeds with long cut-off, and increased very rapidly with higher speeds and shorter cut-offs. The results with this arrangement are shown in Fig. 1.

It was at this stage of the experiments that a theoretical study of the conditions was made with the view to making further changes more intelligently.

It was not expected that the exact valve setting and cylinder sizes could be determined from the study unless great refinement was used in the matter of back pressure, drop in the pressure in the receiver, and wire drawing in the throttle and valves, all of which would vary to some extent with every engine studied. The object was rather, therefore, limited to what a chemist would call a qualitative analysis instead of an exact quantitative analysis.



Dimensions of Gear

	Shown in full lines	Shown in dotted lines
Stroke	28"	28"
Max. Valve Travel	6½"	6½"
Steam Lap	1⅜"	⅞"
Lead	⅛"	¼"
Exhaust Clearance	½"	½"

Valve Events for High Pressure Cylinders.

Cut-off C.O 1-2-3	Release R 1-2-3	Compression C 1-2-3	Cut-off C.O 4-5-6	Release R 4-5-6	Compression C 4-5-6
22.48"	25.42"	.81"	25.42"	26.5"	.404"
17.16"	22.75"	1.75"	17.16"	20.6"	1.55"
5.39"	13.79"	5.25"	5.39"	10.75"	5.72"

Fig. 2—Zeuner Valve Diagram for Three Positions of the Reverse Lever and Two Valve Arrangements.

The plan followed in making the investigation was to determine by means of Zeuner valve diagrams the events of the stroke (cut-off, release, compression and admission) for several different valve arrangements and for different positions of the reverse lever for each valve arrangement. With these events, theoretical

*Mechanical Engineer, Los Angeles, Cal.

indicator cards were drawn for several different ratios of cylinders.

In drawing the indicator cards certain assumptions were made, as follows: The clearance volumes of the high and low pressure cylinders were considered to be equal. The expansion of the steam in the cylinders was assumed to follow the curve of a rectangular hyperbola. There was assumed to be no drop in pressure between the exhaust from the high and the admission to the low pressure cylinders. The receiver volume was assumed to be large enough, so that the admission line of the low pressure cylinder would be horizontal.

The Zeuner diagram, Fig. 2, is drawn for two valve arrangements on the high pressure cylinder showing the reverse lever in three different positions for each.

A similar diagram for the low pressure cylinders gives the valve events as shown in the table below. On these cylinders the valves have a maximum travel of 7 in., a steam lap of 11/16 in., a lead of 9/16 in., and an exhaust clearance of ⅝ in.

Valve Events for Low Pressure Cylinders			
Cut-off in High Pressure	Cut-off in Low Pressure	Release	Compression
22.48" & 25.42"	25.75"	26.06"	.25"
17.16" (L&L=1½")	23.12"	23.5"	.56"
17.16" (L&L=1⅛")	19.5"	20 06"	1.25"
5.39" (L&L=1½")	13.5"	14.38"	2.88"
5.39" (L&L=1⅛")	9.13"	10.0"	4.88"

Theoretical cards were then constructed for one ratio of cylinders and the events shown on the Zeuner diagrams. These are shown in Fig. 3. Fig. 4 shows the figures obtained from the diagrams and cards for these two conditions and for four others.

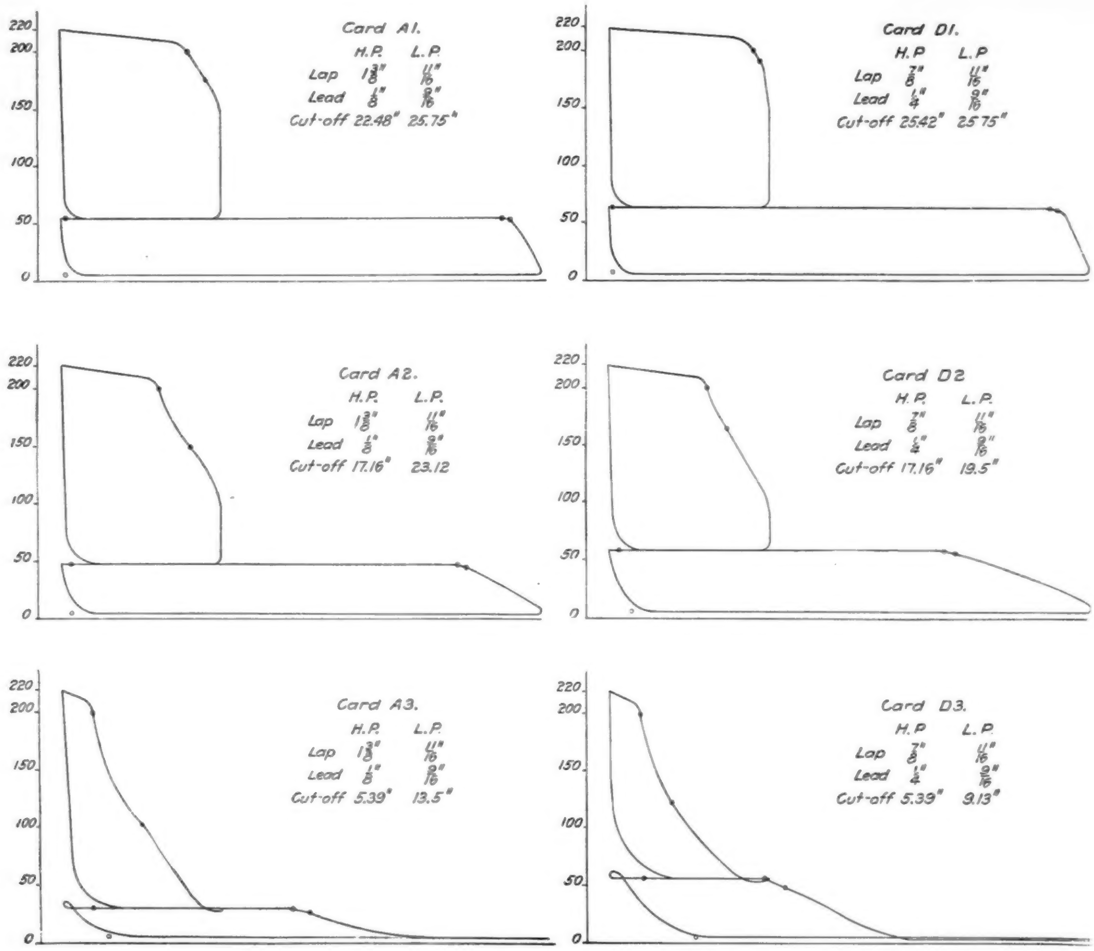


Fig. 3—Indicator Cards Constructed from the Information Given by the Zeuner Diagrams.

From the data thus obtained the curves shown in Fig. 5 were drawn illustrating the relation between the ratio of work in the two cylinders and the cut-off in the high pressure cylinder. There are six curves, each of them representing one of the conditions shown in Fig. 4.

Examining these curves with references to the first question, viz., What valve arrangement will give a constant ratio of work at all speeds and cut-offs? it will be noticed that curves *A* and *E* rise very rapidly, as the cut-off is shortened and an inspection of the valve conditions on which these curves are based shows a very long steam lap in the high pressure cylinders and a very short steam lap in the low. Curves *B*, *C* and *D* do not rise as rapidly as *A* and *E*, as the cut-off is shortened and it will be noticed that they are based on a much shorter steam lap in the high pressure, but the same lap in the low pressure as curves *A* and *E*. Curve *F* is more nearly horizontal than any of the others and is based on valve conditions with the high the same as *B*, *C* and *D*, but the low with a longer steam lap. It therefore appears that a valve setting with the steam laps in the high and low pressure cylinders nearly equal will give a more uniform work distribution than any arrangement with widely different laps.

Again examining the curves with reference to the question of what ratio of cylinders is necessary to give the correct work ratio, it will be seen that as the chart is plotted with this ratio as ordinates the location of the curves, one above the other, will indicate the effect of a change of cylinder ratio. The three curves, *B*, *C* and *D* are arranged with *B* at the bottom, corresponding to the smallest cylinder ratio, and *C* at the top, corresponding to the largest cylinder ratio. Curves *A* and *E* are also located with *E* below, corresponding to a smaller cylinder ratio than *A*. The conclusion to be drawn from these facts is that

the larger the ratio of cylinders, the more work in proportion is done in the high pressure cylinder.

These curves cannot be assumed to give the exact ratio of work which would be found in an actual locomotive under the same conditions. It will, therefore, be necessary to see if it is possible to estimate the location of the actual curves from the theoretical results.

Actual indicator cards would be smaller than the theoretical cards as drawn, due to a higher back pressure, a drop in pressure in the receiver and wire drawing in the steam passages. The low pressure card will lose more area than the high on account of its greater piston area (the theoretical cards are based on cylinder volume). The actual curves will, therefore, apparently lie higher on the chart than the theoretical curves, because the ratio of work in the two cylinders is larger.

This is proved by comparing the curve J and the plotted joints on Fig. 6. Curve J represents the same theoretical study for another locomotive of the same type, while the plotted points are taken from actual indicator cards. The curve J shows a work ratio of about 75 per cent., whereas the points fall mostly between 80 and 95 per cent.

The locomotive now under investigation was, therefore, kept with the 22 in. and 38 in. cylinders and the setting of the valves was changed to conform to the dimensions marked D in the table.

Figure 7 shows the curve D and plotted points from actual indicator cards which were taken. The points will be seen to follow a line at about the same angle as curve D. This shows that a valve arrangement is being used which gives nearly equal work distribution at all speeds and cut-offs, as was predicted by curve D. The actual curve is, however, higher on the scale of work distribution, which confirms the statement made above that the

	Diam. of Cyl.		Cyl. Ratio	High Pressure				Low Pressure				Cut-Off		Release		Compression		Area of Card			Total Area	Tractive Effort	X
Card	High	Low		Valve Travel	Steam Lap	Lead	Exhaust Clearance	Valve Travel	Steam Lap	Lead	Exhaust Clearance	High	Low	High	Low	High	Low	High	Low	Ratio			T / Area High
B 1	26"	38"	2.137	6½"	7/8"	1/4"	1/2"	7"	11/16"	9/16"	5/8"	25.42	25.75	26.5	26.06	.4	.25	247	346	714	593	77500	146
2												17.16	19.5	20.6	20.1	1.55	1.25	215	276	78	491		
3												5.39	13.5	13.79	14.38	5.25	2.88	114	67	1.70	181		
E 1	24"	38"	2.508	6½"	1⅜"	1/8"	1/2"	7"	11/16"	9/16"	5/8"	22.48	25.75	25.42	21.06	.81	.25	238	252	.95	490	64100	141.5
2												17.16	23.12	22.75	23.5	1.75	.56	216	206	1.05	422		
3												5.39	13.5	13.79	14.38	5.25	2.88	114	67	1.70	181		
D 1	22"	38"	2.985	6½"	7/8"	1/4"	1/2"	7"	11/16"	9/16"	5/8"	25.42	25.75	26.5	26.06	.4	.25	204	232	.88	436	57000	150
2												17.16	19.5	20.6	20.1	1.55	1.25	179	197	.91	376		
3												5.39	9.13	10.75	10.0	5.72	4.88	76	73	1.04	149		
A 1	22"	38"	2.985	6½"	1⅜"	1/8"	1/2"	7"	11/16"	9/16"	5/8"	22.48	25.75	25.42	26.06	.81	.25	214	196	1.09	410	53600	141
2												17.16	23.12	22.75	23.5	1.75	.56	196	167	1.17	363		
3												5.39	13.5	13.79	14.38	5.25	2.88	106	51	2.08	157		
C 1	18½"	38"	4.218	6½"	7/8"	1/4"	1/2"	7"	11/16"	9/16"	5/8"	25.42	25.75	26.5	26.06	.4	.25	167	159	1.05	326	42600	158.6
2												17.16	19.5	20.6	20.1	1.55	1.25	149	125	1.19	274		
3												5.39	9.13	10.75	10.0	5.12	4.88	65	45	1.46	110		
F 1	18½"	38"	4.218	6½"	7/8"	1/4"	1/2"	7"	1"	1/2"	5/8"	25.42	24.44	26.5	25.38	4	.5	164	162	1.01	326	42600	
2												17.16	15.12	20.6	18.56	1.55	2.25	133	127	1.05	260		
3												5.39	6.25	10.75	10.0	5.72	6.62	52	47	1.11	99		

Fig. 4—Information Given by the Indicator Cards Arranged in Tabular Form.

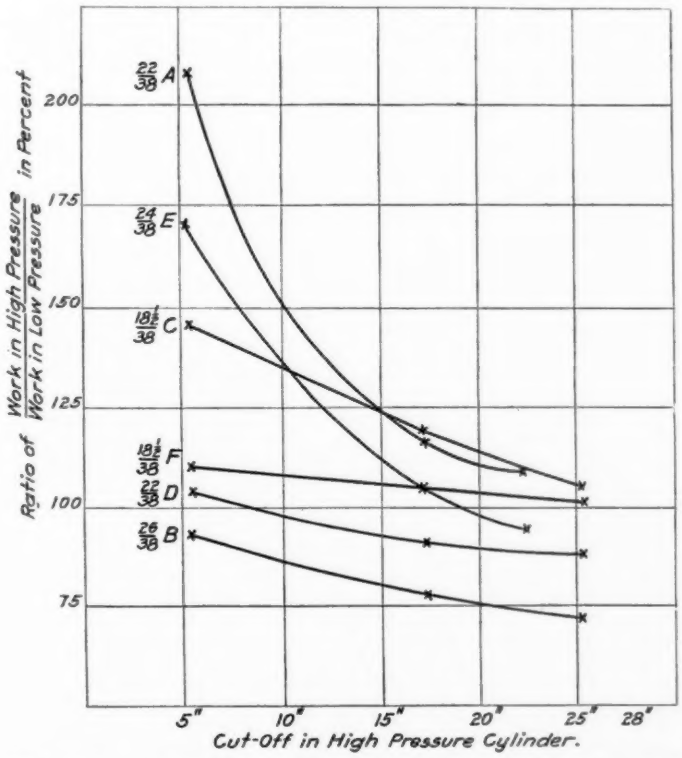


Fig. 5—Curves Showing the Theoretical Distribution of Power for the Conditions Given in Fig. 4.

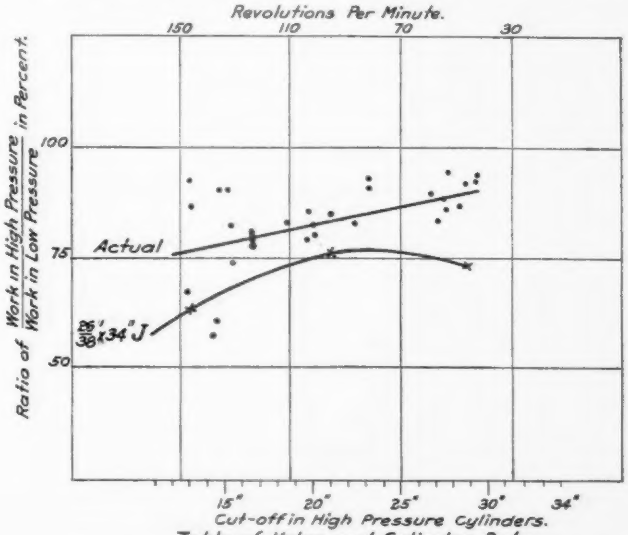


Table of Valve and Cylinder Data.

	H.P.	L.P.
Diameter of Cylinders	26"	38"
Valve Travel	6½"	7"
Lap	1⅛"	1"
Lead	5/16"	5/16"
Exhaust Clearance	1/8"	1/8"

	Cut-off		Release		Compression		Area of Card		
Card	High	Low	High	Low	High	Low	High	Low	Ratio
J 1	28.7	30.4	32.0	32.7	1.47	1.06	224	306	.73
2	20.9	23.7	28.7	29.9	4.09	3.11	195	258	.76
3	13.0	15.5	24.2	25.5	7.53	6.5	123	197	.63

Fig. 6—Comparison of Actual Conditions and a Theoretical Curve of Power Distribution.

actual cards show more work done in the high pressure cylinder than the theoretical cards.

The actual cards with the cylinder ratio of 22 to 38 do not, however, give a work ratio of 1.5, the figure desired. The curve *F* must, therefore, be considered. This curve with 18½ in. and 38 in. cylinders gives a work ratio of about 105 per cent., and it may be judged that in actual service the same cylinders and valve arrangement would give a ratio averaging about 140 or 150 per cent. The steam lap and lead in the low have been changed in this curve in order to bring it more nearly horizontal.

As the desired work ratio is 150 per cent., it appears that the ratio of cylinders shown by curve *F* is none too large. We can then assume that the cylinder ratio can not be less than 4.2, as is used in curve *F*.

We have now answered the first two questions. In order to answer the third, viz.: What sizes of cylinders are necessary to give the best return from the adhesive weight of the locomotive? it is necessary to have a correct formula for tractive effort for Mallet compound locomotives. We are dealing with a cylinder ratio very much out of the ordinary, and as the tractive effort does not vary in a direct ratio with the size of the high pressure cylinder alone, as is shown in column *X* of Fig. 4, which gives the tractive effort divided by the area of the high pressure cylinder. Nor does the tractive effort vary directly with the size of the low pressure cylinder alone, since the varying tractive efforts in Fig. 4 are all from the same size of low pressure cylinder. Therefore, those formulas which are based on either the high pressure cylinder or the low pressure cylinder only, cannot be used.

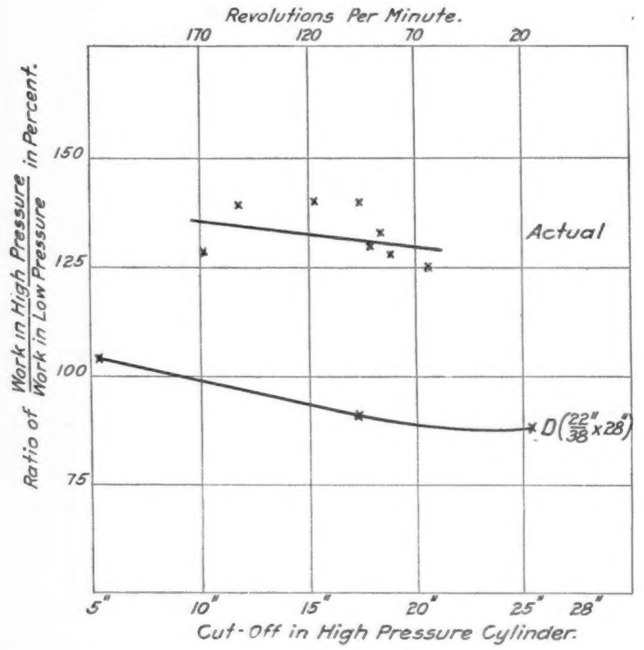


Fig. 7—Results of First Trial Compared with the Theoretical Curve.

The formulas given in Fig. 8 show what has been proposed so far, with the results they give for two ratios of cylinders. It will be noted that the results differ very much. Tractive effort of 68,800 lbs. and 61,050 lbs. are obtained by the formula about to be developed. The first corresponds most nearly to the Baldwin formula No. 2 and to D. F. Crawford's formula, whereas in column *B*, 61,050 lbs. correspond most nearly with Baldwin formula No. 1, and to G. R. Henderson's formula. This shows that the new formula is of different form and gives results which do not follow any of those previously in use.

The Baldwin formulas will not apply to all ratios of cylinders, as they are based entirely on the size of the high pressure cylinder. The formula of B. R. Van Kirk will not apply, since it makes the ratio of work decrease as the cylinder ratio increases, whereas the charts just discussed show the opposite to be true. The formulas of D. F. Crawford and Geo. R. Henderson seem to be more nearly adapted for our use, but they will not apply for the following reason.

Change the formula to the following form:

$$\text{T. E.} = \frac{1.7 \times P \times C_l^2 \times S}{(R+1)\,D} = \frac{1.7 \times P \times C_h^2 \times R \times S}{(R+1)\,D}$$

which is true because $C_l^2 = R\,C_h^2$. Notice that for very large values of *R* the formula approaches the value

$$\text{T. E.} = \frac{1.7 \times P \times C_h^2 \times S}{D}$$

which is twice as large as it should be.

The formula of the American Locomotive Company, would of course, be correct if a table showing the correct value of *k* for all values of *R* was available. Such a table, however, has not been published.*

An examination of the theoretical indicator cards drawn for the different cylinder ratios shows that starting cards are very nearly rectangular in form, and their areas can be easily figured if the pressure in the receiver is known, since the mean-effective-pressure in the high is the difference between the boiler pressure and the receiver pressure, and the mean-effective-pressure in the low is approximately the receiver pressure. These pressures should be reduced by a factor, such as .85, just as is done in the formula for single expansion engines.

The problem then is to find the receiver pressure for all ratios of cylinders. The formula which gives this pressure must be such that if the ratio be either one or infinity the formula will become

$$\frac{D}{.85\ P.\ C_h^2\ S.}$$

This means that in the formula for receiver pressure *R* (the ratio of cylinders) must appear in the denominator by itself or raised to some power. The receiver pressure is always some fraction of the boiler pressure, therefore, the formula adopted must have the form $P_l = P \div R^x$. It is then necessary to determine what value of x must be used.

This will be done by working backwards from the pressures on the theoretical indicator cards as is shown in the following table:

Diameter of cylinders.	Admission pressure from theoretical indicator cards.	Ratio.	Cylinder areas.	Ratio = R.	
18½ in. and 38 in.	220 lbs. and 37 lbs.	5.95	269 sq. in. and 1,134 sq. in.	4.218	$\frac{\log 5.95}{\log 4.218} = \frac{.775}{.625} = 1.24$
22 in. and 38 in.	220 lbs. and 57 lbs.	3.86	380 sq. in. and 1,134 sq. in.	2.985	$\frac{\log 3.86}{\log 2.985} = \frac{.587}{.474} = 1.237$
26 in. and 38 in.	220 lbs. and 86 lbs.	2.56	531 sq. in. and 1,134 sq. in.	2.137	$\frac{\log 2.56}{\log 2.137} = \frac{.408}{.329} = 1.24$
				Average........................	1.24

The value of x is therefore 1.24, and the formula for tractive effort becomes

$$\text{T. E.} = \frac{.85\,S\,(P_l C_l^2 + P_h C_h^2)}{D}$$

$$\text{Where } P_l = P \div R^{1.24}$$
$$P_h = P - P_l$$

This formula will be used in determining the size of cylinders necessary to utilize the adhesive weight of the locomotive.

*[The values of *k* used by the American Locomotive Company are derived from actual tests and include the normal range of *R* only.—EDITOR.]

The weight on drivers in this case is 268,000 lbs. Assume that 9/40 of this weight is a proper drawbar pull. The factors ¼, 9/40 or ⅕ have been established by practice. In the case of single expansion engines the tractive effort has always been figured by a formula which gives the tractive effort at the drawbar. The formula just derived also gives the tractive effort at the drawbar, so the same adhesion factors will apply.

$$268{,}000 \text{ lbs.} \times \frac{9}{40} = 60{,}300 \text{ lbs. tractive effort desired.}$$

In Fig. 8 the 68,800 lbs. was derived from this new formula using 26 in. and 38 in. cylinders. Trial will therefore first be made with a 24 in. high pressure cylinder and, as previously decided, a cylinder ratio of 4.2. If low pressure cylinders 49 in. diameters are selected, the ratio is 4.17. Then,

$$P_1 = \frac{220 \text{ lbs.}}{4.17^{1.24}} = 37.6 \text{ lbs.}$$

$$\text{T. E.} = \frac{.85 \times 28}{73} (37.6 \times 2{,}400 + 182.4 \times 576) = 63{,}600 \text{ lbs.}$$

As this is too large, a trial with smaller cylinders must be made. 23½ in. high pressure and 48 in. low pressure cylinders also give a ratio of 4.17, and the tractive effort equals:

C_h = diameter of H. P. Cylinder in Inches P = boiler pressure
C_L = diameter of L. P. Cylinder in Inches P_1 = absolute pressure = P + 14.7 lbs.
S = stroke of Piston in Inches R = ratio of cylinders
D = diameter of Driving Wheels in Inches T = tractive effort

		A	B
Baldwin Locomotive Works Formula 1	$T = \frac{C_h^2 \times S \times 4/3 P}{D}$	76000 lbs.	62200 lbs.
Formula 2	$T = \frac{C_h^2 \times S \times 1.2 P}{D}$	68450 lbs.	56000 lbs.
B. R. Van Kirk	$T = \frac{C_h^2 \times S \times .53 P}{D} + \frac{C_L^2 \times S \times .30 P_1}{D}$	71300 lbs.	88700 lbs.
D. F. Crawford	$T = \frac{1.7 \times P \times C_L^2 \times S}{D}$	66100 lbs.	64000 lbs.
G. R. Henderson	$T = \frac{1.6 \times P \times C_L^2 \times S}{D}$	62300 lbs.	60200 lbs.
American Loco. Co.	$T = \frac{C_L^2 \times P \times k \times S}{D}$ $k = .53$ for $R = 2\frac{1}{2}$	64500 lbs.	
Paul Weeks	$T = \frac{.85 S (P_L C_L^2 + P_h C_h^2)}{D}$	68800 lbs.	61050 lbs.

Where $P_L = \frac{P}{R^{1.24}}$ and $P_h = P - P_L$

Column A gives results for a locomotive with 26" and 38" cylinders, 28" stroke, 73" drivers, $R = 2.136$

Column B gives results for a locomotive with 23½" and 48" cylinders, 28" stroke, 73" drivers, $R = 4.17$

Fig. 8—Tractive Effort Formulas for Articulated Locomotives.

$$\text{T. E.} = \frac{.85 \times 28}{73} (37.6 \times 2{,}304 + 182.4 \times 552.5) = 61{,}050 \text{ lbs.}$$

This gives an adhesion factor of 4.39, which is very nearly 9/40.

Cylinders 23½ in. and 48 in. in diameter are therefore the correct size for this locomotive.

CONCLUSION.

The problem called for the answers to three questions. These are repeated and accompanied with the correct answers.

What valve arrangement will give a constant ratio of work between the two pairs of cylinders at all speeds and cut-offs? It appears that the proper valve setting is with the steam laps in the high and low pressure cylinders nearly equal and of the proper length to give a maximum cut-off at about 90 per cent. of the stroke.

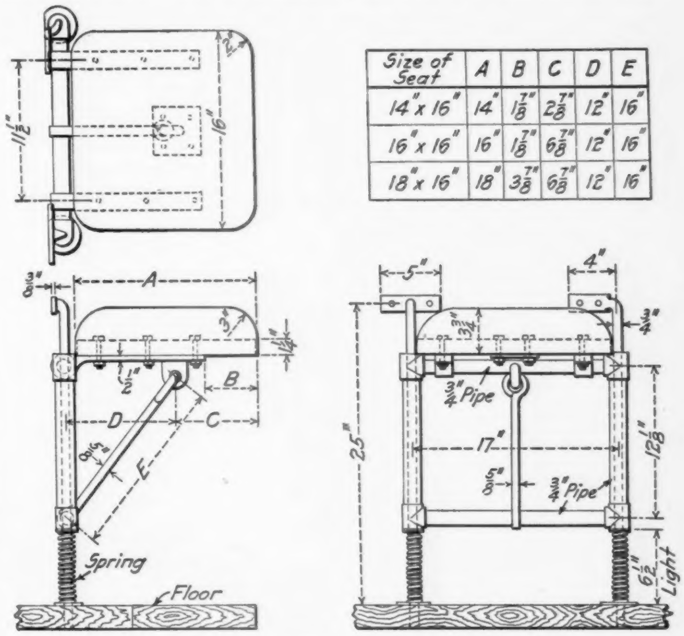
What ratio of cylinders is necessary to give a correct ratio of work? In this case where the high pressure cylinders must do 1.5 times as much work as the low, the low pressure cylinders must be about 4.2 times as large as the high.

What sizes of cylinders are necessary to give the best return from the adhesive weight of the locomotive? As the locomotive under consideration has 268,000 lbs. weight on the drivers, 28 in. stroke and 73 in. drivers, the cylinders must be 23½ in. and 48 in. in diameter.

LOCOMOTIVE CAB FURNISHINGS

BY ALDEN B. LAWSON.

Most railroads have, at one time or another, been in controversy with their enginemen regarding the accommodations on the locomotives. Various designs of seats, seat boxes, arm rests, etc., have been tested to meet the views of the men, whose comfort should have due consideration. In the modern locomotive the space in the cab is often crowded and it is difficult to locate



Size of Seat	A	B	C	D	E
14" x 16"	14"	1⅞"	2⅞"	12"	16"
16" x 16"	16"	1⅞"	6⅞"	12"	16"
18" x 16"	18"	3⅞"	6⅞"	12"	16"

Fig. 1—Drop Spring Seat.

all the fittings conveniently and just where the engineman can reach or see them without moving from his seat.

The seats, arm rests, etc., which are described in this article have been adopted as standard by a large railroad and in doing so the wishes of the men were carefully considered and every effort made to conform to them as far as possible. The engineer's seat shown in Fig. 1 is a drop type, rigidly secured to

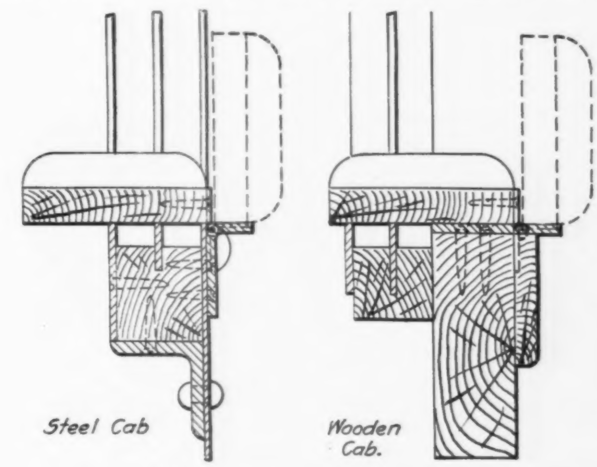


Fig. 2—Hinged Arm Rest.

the side of the cab, and is fitted with springs. To suit all classes of locomotives three sizes are used, as shown in the table, the larger size being applied wherever possible. The seat is held in position by an arm and when it is desired to lower it, it is raised sufficiently to permit the arm to disengage from the support, the seat then dropping against the side of the cab. The covering for the cushion may be easily obtained from old Pantasote car curtains, etc.

Various types of arm rests have been tried out, some loose,

some screwed into position and some attached by a chain so that when it is desired to close the windows the arm rest may be

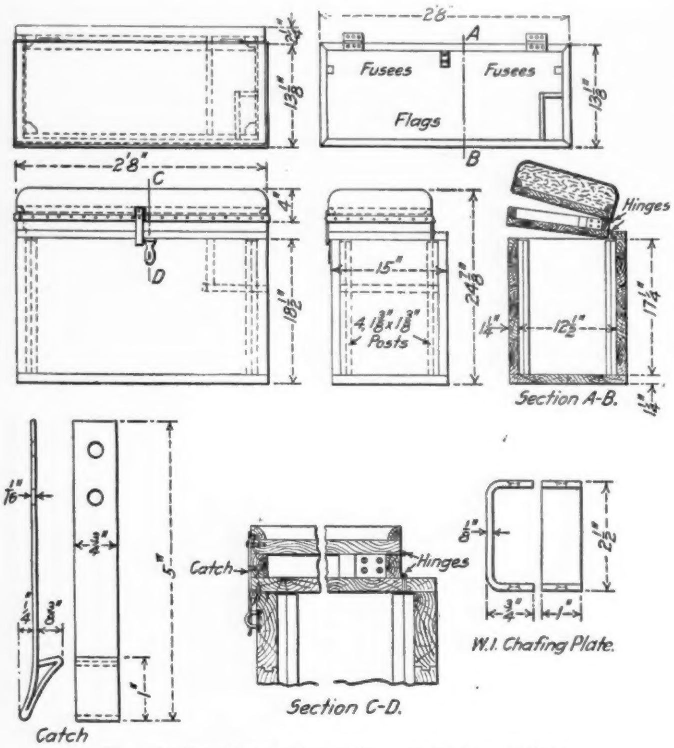


Fig. 3—Combined Seat Box and Flag Holder.

removed. None of these types were entirely satisfactory, and many were either lost or thrown away. To overcome this, the

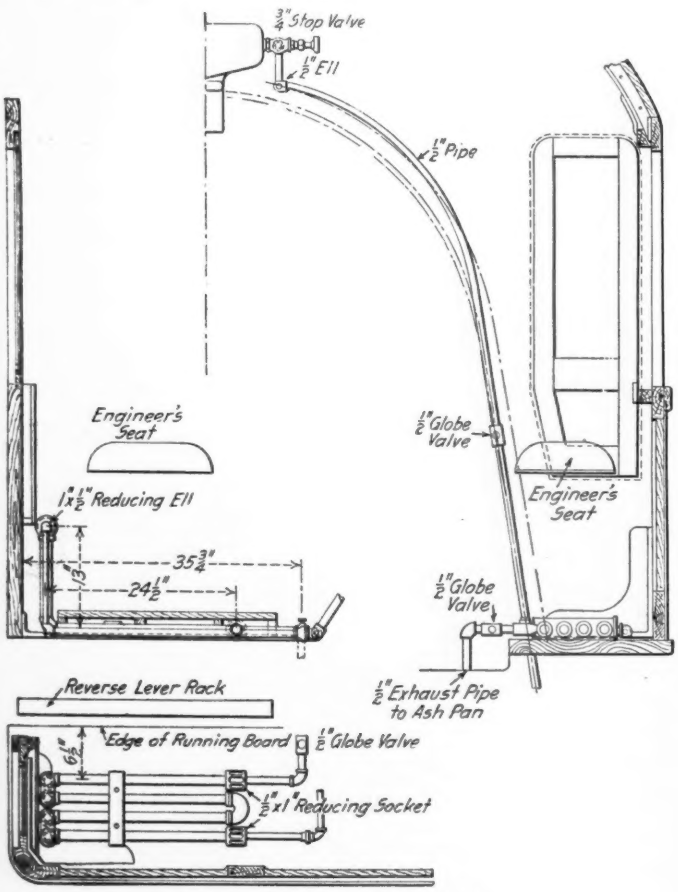


Fig. 4—Details of Cab Heater.

hinged type shown in Fig. 2 was adopted. This is hinged to the window sill in such a way as to permit its being swung out of the way when it is desired to close the windows. A shelf is fastened to the cab to support it.

The fireman's seat box shown in Fig. 3 combines a seat and a box for flags and fusees, as well as providing a receptacle in the bottom for clothes and other private property. The flags, fusees and torpedoes being in a separate compartment, may be neatly arranged and do not become mixed in with the tools, etc., as is often the case when a separate box is not provided. The box is secured to the cab floor and may be locked to secure the fireman's personal property, leaving the flag box unlocked so that its contents are accessible at all times.

The cab heater shown in Fig. 4 is used only under the engineer's seat, and consists of four or five lengths of 1-in. pipe, depending on the width of the cab, connected by return bends and

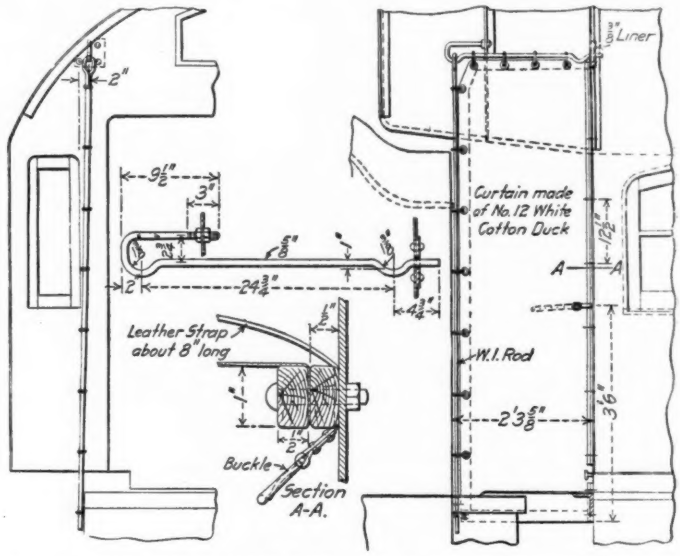


Fig. 5—Side Curtain Fitted with Anchor Rod to Prevent Flapping.

elbows, and resting on the cab floor. These pipes are extended up behind the engineer's back and very materially add to his comfort during cold weather. On passenger locomotives, the steam supply is taken from the train heater pipe beyond the reducing valve, and on freight locomotives the heater pipe is connected to the manifold or turret, as shown in the drawing. The waste valve is left slightly open to prevent condensation and freezing, and a wooden tread is used to cover the steam pipes.

The side curtain shown in Fig. 5 is made of white duck and is fitted with an anchor rod at the back to hold it in place and prevent flapping and tearing. Wrought iron edge rings are inserted for the guide rod, one end of which extends through the back of the cab, while the other end is secured to a carline on the roof extension, and is arranged with nuts so it may be readily taken down.

Penalties Under Federal Laws.—The total amounts, exclusive of costs, collected from the railroads as penalties under the Safety Appliance, Hours of Service and Ash Pan laws, as of November 1, 1912, are as follows: Safety Appliance Law, $259,900; Hours of Service Law, for trainmen, $40,921; for telegraphers, $11,715; and for failures to file reports, $500; Ash Pan Law, $3,400. The grand total was $316,436.

Steam Turbine Advantages.—The benefits from using superheated steam are not the same in the turbine and reciprocating engines, although they are considerable in both. The increased economy of the reciprocating engine using superheated steam is because of reduced initial condensation and valve leakage. The turbine benefits by the reduced frictional resistance offered to the rotor by the dryer steam, in addition to the reduction of steam leakage past the blades.—*Power.*

SHOP PRACTICE

SELECTION OF OPERATORS FOR OXY-ACETYLENE WELDING

BY J. C. REID.

Oxy-acetylene welding and cutting, which was introduced into the United States about seven years ago, is being extensively used in railroad shops, and is by many considered one of the most important factors in repair work. Its field of application is broad, and its money-saving possibilities are surprisingly large. In welding it is not restricted to any particular class of metal; steel, cast iron, brass, aluminum, etc., can be worked. In cutting it is restricted to steel, wrought and malleable iron, but its cutting speed in these metals may fairly be compared with that of a sharp saw through soft pine, and the cut is very nearly as smooth.

Oxy-acetylene welding is considered a poor investment by many railroads, and the welds made by the process very unsatisfactory. If some one would visit each person who has this impression and find out the direct cause of it, the writer believes that in nearly all cases it would be found to be based on some piece of work or demonstration performed by an incompetent welder. There are many people who claim to be oxy-acetylene welders, and who, when given an opportunity to demonstrate their ability, show that they know almost nothing of the work; it is such men that have given many people a poor opinion of the process. The art of oxy-acetylene welding is not one that can be mastered in a few days, or even in a few months. Something new turns up each day, which necessitates study and research to determine just how to proceed in order to make a success of the work. I have in mind a certain man who is considered one of the best welders in the United States; when asked if he was an expert he replied, "I am not an expert, but merely learning."

When a welding plant is installed one of the first problems which arise is that of selecting a man to handle it. The one chosen may be a machinist, machinist handyman, machinist's helper, boiler maker, boiler maker handyman, boiler maker's helper, or possibly the job will be advertised on the bulletins and given to the first applicant. The writer has had several years' experience with oxy-acetylene, both in doing the actual work and in instructing others, and can say from experience that there are some people who can never make successful welders. There are others who, in their own estimation, can learn it in a few weeks; while there are still others who are quick to take to the work, become interested and learn something each day no matter how long they continue. The man selected may be of the latter type, and still after several months his work may not give satisfaction.

If boiler and general repair work is to be done, which is the case in practically all railroad shops, there should be a boiler maker put on the work and not a machinist. He should be a good practical boiler maker; one who can think for himself and does not need to be told how to do each individual job. He should know the effect of heat on iron, so that he will understand just where to direct his torch in order to produce a draw on any part of the work. He should be thoroughly acquainted with patch work, so that he will know just how to cut out a patch to obtain the best results, and he should oversee the laying out of patches preparatory to welding. If the shop is large enough, there should be a boiler maker assigned to do the work of laying out patches, etc. He will soon become familiar with it and will seldom have to call on the welder for help as to how to proceed.

A large part of the success in welding is due to preparing the job for the weld and knowing when and how to pre-heat. Some patches, for example, require corrugation; others a slight roll, while still others require neither. The majority of machinists would be at a loss to know just how to handle this work unless they had had considerable boiler experience, which is seldom the case. Much damage may be done in a firebox by one unfamiliar with boiler work.

Most of the railroads that use the oxy-acetylene process keep a record of all the work done in order that it may be seen at a glance how much money and time the machine is saving the company each month. These reports should be made out daily by the operator and should allow for the time to prepare the work for the weld, time consumed in welding, labor, oxygen and acetylene gas, material, and time to complete the job after the weld is made. The time and cost of doing the same job by the old method should also be shown and at the end the saving effected by using the oxy-acetylene process should be given. Here again, the advantages of a boiler maker over a machinist are evident. Being thoroughly acquainted with boiler work and knowing all the piece work prices, he can readily compute the cost of doing the job by the old method.

Many companies have trouble in keeping a man after he becomes a good welder. From the record he keeps he sees that he is saving the company a large amount of money, and if his rate of wages is not raised he soon becomes dissatisfied and leaves. It is essential that the man receive a fair rate of wages, which should be a few cents more than a boiler maker's rate, for if he becomes dissatisfied it is easy for him to shirk, as he is probably the only man around the plant who knows anything of the work.

Beginners in this work all seem to be afraid to try vertical and overhead welds, such as patches in side sheets or crown sheets. After they have done some of this work, and have learned how to control the metal, they find the work becomes more simple each day.

REPAIRING INJECTORS

BY CHAS. MARKEL,
Shop Foreman, Chicago & North Western, Clinton, Ia.

The standard method of repairing injectors in use on the Chicago & North Western has been very successful. Injector failures have been greatly reduced, on some divisions being practically eliminated, since its introduction. This system centralizes the repairs at one point on each division and includes the furnishing of limit gages and complete instructions for procedure to each engine house or other point where injectors are inspected. Blue prints are furnished each of the designated repair shops giving the name and pattern number of every part of all sizes of injectors in use, and when a new part is required it is ordered from the Chicago shop where all parts, finished to standard size by the use of jig and box tools, are kept in stock. All engine houses are furnished with hand tools for reseating the steam or jet valve seat without taking the injector from the locomotive. The division repair shops have limit gages as to range of wear allowable and a set of special tools for making complete repairs to all parts.

When an injector is reported not working the instructions require that the inspector shall first see if the opening is free between the check valve and the injector, next to see if the branch and feed pipes have an air leak and if the tank hose and tank well are tight. If these are found to be in good condition, the injector is removed from the locomotive and a repaired one sub-

stituted for it. It is then sent to the division repair shop where it is immediately repaired and returned.

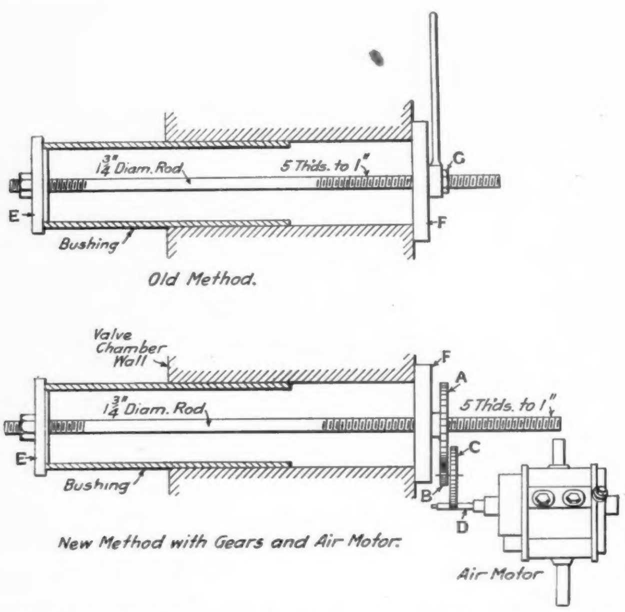
All injectors sent to the shop are first taken apart at the throttle, the jet and the water opening and are placed in a muriatic acid bath where they remain until no agitation of the acid is seen, when they are washed with clear water. They are then taken to a bench where the body part is separated from the front part by a special clamp and screw which separates them without hammering, wedging or damaging any of the parts. The nozzles are then pressed out under a screw press and if not worn practically to the limit are again returned to place. All repairs are usually made at the bench and in the vise without taking any part of the injector to a machine. The only machine operation required is when the jet seat is worn to the limit. It is then taken to a lathe which holds and centers it in a special chuck and the seat is drilled and bored out and tapped with a special tap. A special pattern of brass bushing is then screwed in place and drilled and reseated, bringing it to standard size. Standard gages are provided for all parts that may need repairs and each new part is formed to fit the proper gage. If the threaded connection where the steam or water inlet pipe connect is worn and has poor threads, it is expanded by a roller and a solid die is run over the thread. Hand tools are used for facing all ball joints and the joints on the body where the jet and throttle bonnets screw in, as well as for reseating bonnets if they require it.

At stated periods, an injector repair expert visits the division engine houses and inspects their tools, gages and methods. This insures these points having good standard tools on hand and keeps the injector repairman at the small terminals posted as to the latest tools and best methods of doing the work.

PRESSING IN PISTON VALVE BUSHINGS

BY V. T. KROPIDLOWSKI.

In pressing in valve chamber bushings it is general practice to do the work by hand, which requires two men working from one to two hours for each bushing. At the suggestion of the general foreman of the shop with which the writer is connected, an arrangement of gearing operated by an air motor was de-

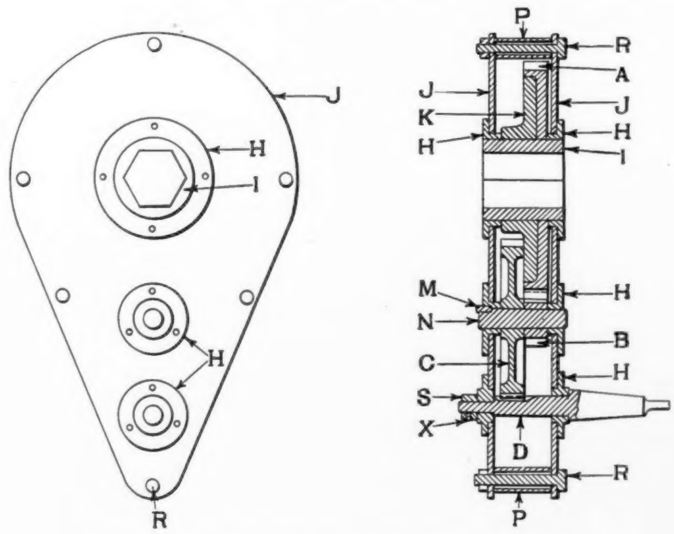


Old and New Methods of Pressing in Piston Valve Bushings.

signed, by means of which the time is reduced to half an hour and but one man is required.

One of the illustrations shows the old method of pulling in the bushing by hand by means of a wrench revolving the nut *G*. The same illustration shows the new arrangement, the rod, heads *E* and *F* and nut *G* being retained, but instead of the wrench the train of gearing is attached to the nut and the motor replaces the men.

The other illustration shows the detailed construction of the gearing, as assembled in the sheet steel frame. The gears of a discarded lathe were made use of to avoid the expense of cutting new ones; they have a width of face of 1 in. To make the gear *A* suitable for turning the nut *G* it was necessary to turn a countersunk depression in its body and rivet a wrought-iron disk *K* to it. The gear with the disk fastened to it was then bored out for the hub *I* to be pressed in. This hub is hexagonal on the inside to fit the nut *G*. The spindle *D* is of tool steel, one end of which is turned to a Morse taper to fit the motor socket. The body is then turned down to 1¼ in. diameter and is milled with teeth to mesh with the gear *C*, the other end being again turned down to 1 in. diameter and threaded to receive the nut *S*,



Machine for Pressing in Piston Valve Bushings.

which is held in place by the dowel *X*. The diameter of the pitch lines of the gears in the train are as follows: *A*, 11½ in.; *B*, 2½ in.; *C*, 8 in., and *D*, 1⅛ in.

The frame *J*, which also forms the casing, is made of 3/16-in. sheet steel. It was first roughly punched out in a punching machine to the shape shown with a ¼-in. punch, and the periphery was afterwards trued up on an emery wheel. It was then put under a steam hammer and straightened. The necessary holes were drilled and the larger ones bored out; brass bushings, *H*, were pressed in and riveted to the plate, serving as bearings. The sheets are held in place by the bolts *R*, and parted by the pipes *P*, and the periphery is closed by a galvanized-iron band.

This arrangement has given good satisfaction and with a No. 1 Little Giant motor, has ample power for the work. On one occasion it appeared to work so easily that the foreman thought the bushing was too loose; but when he detached the machine and had a man try to turn the nut with a 36-in. wrench, he could not move it, and two men could barely turn it.

DEFECTIVE APPLIANCES ON RAILROAD ROLLING STOCK.—The report made to the Interstate Commerce Commission by the chief inspector of safety appliances states that during the fiscal year 1912 there were inspected 451,090 freight cars, of which 29,091, or 6.44 per cent., were found to be defective. The number of defects reported was 34,337. There were 17,120 passenger cars inspected, of which 348, or 2.03 per cent. were found to be defective, the number of defects reported being 780. The total number of locomotives inspected was 22,182, of which 697, or 3.14 per cent., were defective. The number of defects reported was 904.

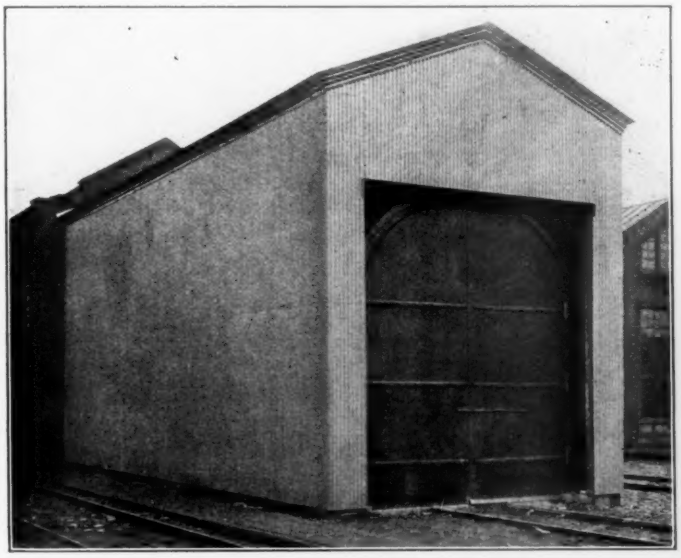
PAINTING STEEL PASSENGER CARS*

Artificial Method of Drying Saves Ten Days on Each Car and Gives a More Durable Surface.

BY C. D. YOUNG,
Engineer of Tests, Pennsylvania Railroad.

The artificial driers and gums ordinarily used in hastening the time of drying and hardening of the various coats and permitting the necessary rubbing, continue their action so that the paints and varnish increase in hardness and brittleness, rendering them susceptible to cracking and chipping, and the process of disintegration is hastened by the excessive expansion and contraction of the steel surfaces as compared with wood. The linear expansion of steel being more than twice that of wood would seem to indicate the use of more elastic coatings than formerly used for wooden cars.

This fact has been borne out in the service of the paint in a great many cases in an investigation which recently came under my observation. It was noticed that when some of the equipment had been in service about four months, the interiors of the cars were showing varnish cracks and checks. As time went on, more cars gave evidence of this deterioration, the final outcome being that an investigation was made to see how serious the condition was. Some 400 cars were carefully examined, special attention being paid to choose cars built by various manufacturers, where different makes of surfacers and varnishes were employed. An endeavor was also made to determine whether the cracking of the painted surfaces was confined to the varnish coats or the surfacer coats, or both.



Exterior of Oven Used for Baking Paint on Steel Cars.

The result of this examination showed that the exteriors, including the sides, ends and vestibules, were in fair condition. There were a few exceptions to this, but they amounted to less than 6 per cent. of the total having serious varnish and surface cracks. Interiors were found generally to be in a poor condition. About 80 per cent. of the equipment examined had the varnish checked through to the surfacer.

Some of these conditions developed after four to eight months' service, indicating either that an entirely new system of painting would be necessary to overcome these troubles, or that a more elastic paint would have to be used for interior finishing under the present existing practice of painting steel.

To obtain some data indicating what should be done to meet the conditions, preliminary experiments were made by painting a number of panels and baking them in a heated oven. Repeated experiments along this line indicated that artificial driers could be almost, if not entirely, eliminated in the paint formulas and that more elastic materials could be used without the aid of artificial oxidizing agents. It was also observed that the elastic varnish used on the exterior of the cars could, under this system, be used to advantage on the interior, and by the aid of the heat of the oven they could be dried to the desired hardness, permitting the rubber with oil and pumice to get a flat finish.

The outcome of the experiments indicated that it would be desirable to extend the experimental panels to a full size car and, therefore, a proper baking oven was planned that would accommodate one of the largest existing steel passenger cars for the purpose of baking each coat as applied to the exterior and interior surfaces.

This oven is 90 ft. 3 in. long, 13 ft. wide and 15 ft. high. The frame work is made up of 3-in. I-beams for the sides, spaced 5 ft. centers. The roof framing is made of the same sections and curved to conform closely to the contour of the car roof. Each end of the oven has two large doors. The oven is lined on the inside with 1/8-in. steel plate, and on the outside with galvanized iron of 0.022 gage. The 3-in. space is filled with magnesia lagging, thus effecting the needed insulation. The doors are insulated in a similar manner. Along the walls of the interior of the oven are placed 16 rows of 1½-in. steam pipes, and along the floor, close to the walls, are arranged manifold castings with small lengths of pipe tapped in them at right angles. By this means over 2,000 sq. ft. of heating surface is provided. A

A Steel Car in the Oven.

*Abstract of a paper presented at the Railway Session of the American Society of Mechanical Engineers, April 8, 1915.

steam pressure of approximately 100 lbs. to the square inch is used, making it possible to get an oven temperature of over 250 deg. Fahr. Rectangular openings, made adjustable, are provided on the sides near the floor line, allowing the necessary admission of air for circulation. Four 8-in. Globe ventilators are spaced at equal distances in the roof, likewise provided with dampers to regulate the size of the opening. By this means of ventilation, fresh air, which is required for the proper drying of paint, is obtained, as well as providing for the egress of the volatile matter present. Automatic ventilation and steam regulation have not, at the present time, been applied, but these have been considered advisable, if the result of the experiment seems to warrant a more extended application of the practice.

A track is placed on the floor of the oven and connected at each end with other tracks leading into the regular paint shop where the different coats of paint are applied to the car before each baking operation.

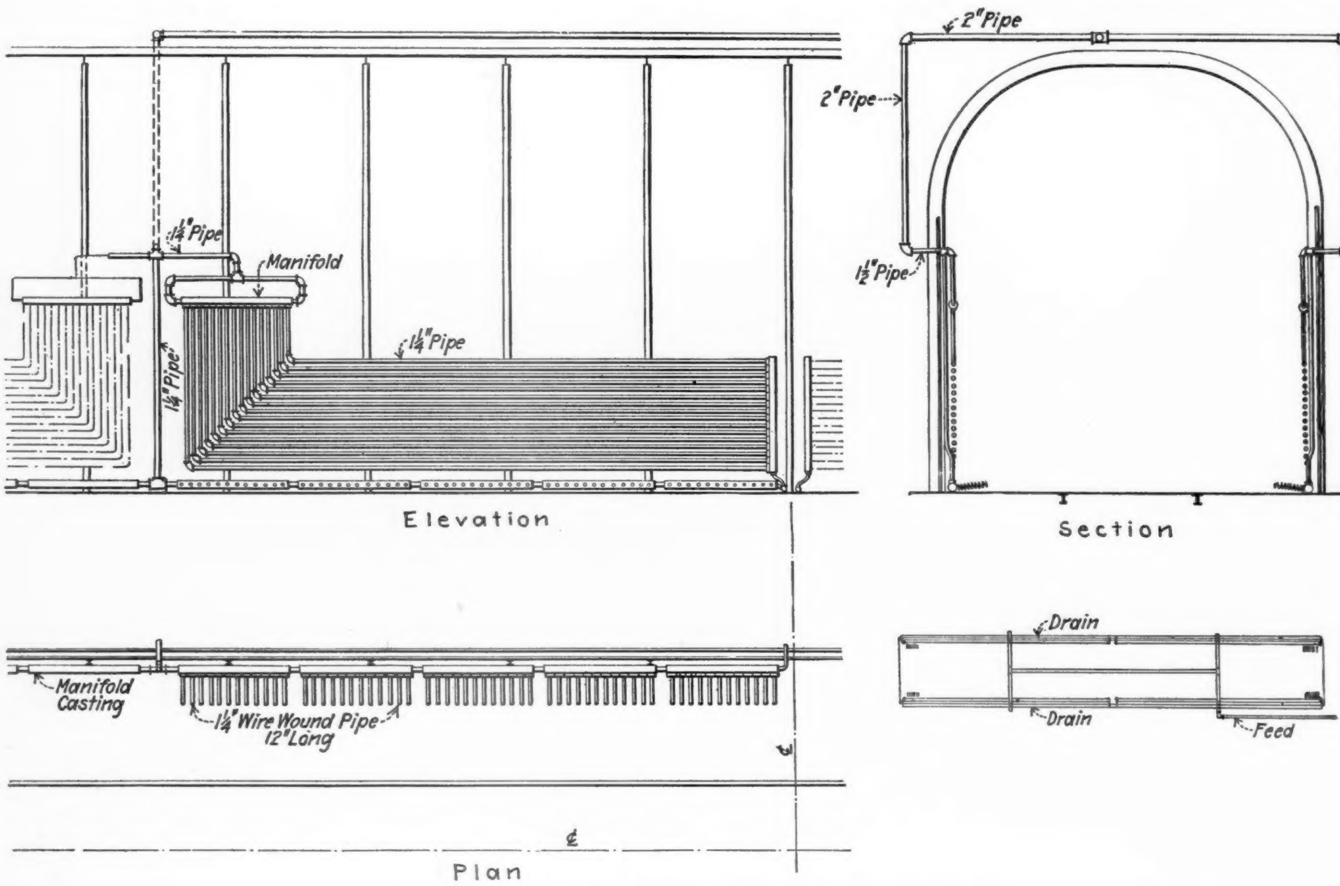
The method of painting a car in this oven is briefly as follows: First, a priming coat is given the exterior and interior of car, which is then moved into the oven and baked for three hours. The temperature at the start is about 160 deg., but rapidly rises at about 1 deg. per minute until a temperature of 250 deg. is reached, requiring about 1½ to 2 hours. The oven is held at this temperature until the lapse of 3 hours, when the car is withdrawn, allowed to cool sufficiently to work on, after which the surfaces are glazed and depressions and uneven places puttied. The car then receives its first coat of surfacer, is returned to the oven for 3 hours, baked and removed for additional coats which vary from two to three in number as the needs of the case require.

After the last coat of surfacer has been applied and baked, the outside surface of the body of the car is rubbed down with emery cloth and oil to produce a flat and smooth surface. The various color coats used, such as tuscan red on the outside, pale green, bronze, and bronze green on the inside, are then put on. Two coats of each color are required to get standard shades. Each coat of color is likewise baked.

Time Schedule for Painting Exterior and Interior of Steel Passenger Cars.

	Outside			Inside		
Period of Work	Body	Roof	Trucks	Body above window	Head-lining	Body below window sills
1	1st prime	1st prime	......	1st prime	1st prime	1st prime
2	glaze	......	......	glaze	glaze	glaze
3	1st surface	......	......	rub-ground	rub	rub
4	2d surface	2d prime	......	......	......	......
5	3d surface	......	......	......	......	......
6	rub	......	......	......	......	......
7	1st tuscan	3d prime	......	2d ground	1st green	1st green
8	2d tuscan	......	......	stipple	......	......
9	stripe and letter	......	......	......	......	......
10	1st varnish	......	truck	1st varnish	......	2d green
11	2d varnish	......	color	2d varnish	......	......
12	3d varnish	......	......	3d varnish	......	1st varnish
13	......	......	......	rub	2d green air dry	......

The car then receives the required lettering, striping, etc., after which the outside and inside surfaces get three coats of a high grade finishing varnish, especially adapted for the baking process. Each coat of varnish is baked at a temperature from 120 deg. Fahr. at the start to 150 deg., which is maintained until the expiration of 3 hours. The interior surfaces of the car are then rubbed with pumice and oil, giving the flat finish desired, thus completing the painting of the car.



Steam Piping in Oven for Baking Paint on Steel Passenger Cars.

To illustrate better the schedule of operation followed, or the timing of the various coats, both for the outside and inside of the car, to secure the most economical conditions, the above table is given. The column headed "Period of Work" does not necessarily refer to days, as in some cases three of these periods are performed in one day.

All of the work done by the baking process of painting can be accomplished in six to eight days, thus effecting a saving in time of about ten days as compared with the

standard or present air drying system. Further, the paints and varnishes have been worked up so that they are especially adapted for this baking process, having greater elasticity. Exact formulas for the various mixtures are well defined, so that uniformity in material is expected, thus giving greater durability, better appearance and longer life for the paint work.

The checks and cracking previously found will be considerably lessened, if not almost removed. By oven painting the work is done under more uniform conditions, which at the present time are so hard to control. It enables the surfaces of the car to be heated uniformly and dried thoroughly, thus removing any objectionable moisture before the first priming coat is applied, which is a very desirable feature of the new method.

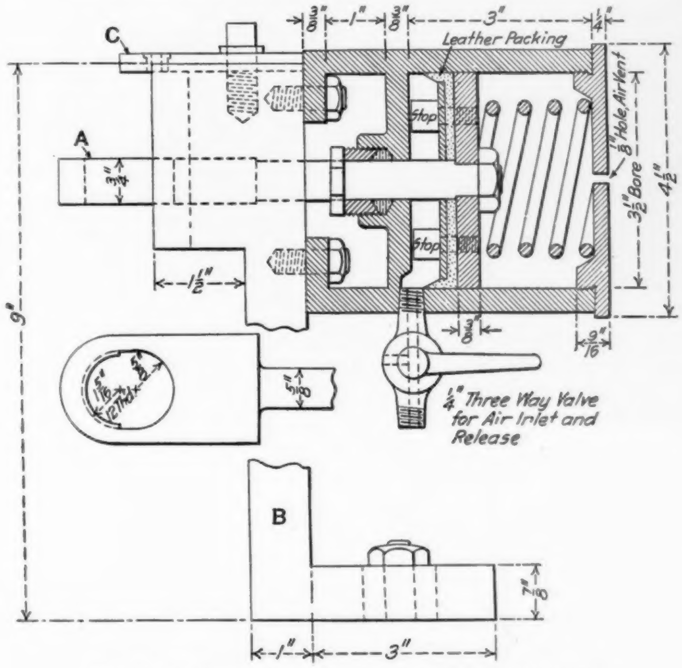
A considerable saving will be effected by the shorter time that cars will be held out of service when undergoing repairs and repainting in the shops. It is expected that dirt, soot, etc., will not adhere or imbed themselves so readily and that the general appearance of the car will be improved by the baking method.

This oven was placed in service the early part of this year, and the results of the complete car at this time seem to justify the experiment. They seem to indicate that the results obtained from a small panel can be duplicated in the full size passenger equipment car and that, if this is the case, this method of painting can not only be used to advantage for the painting of steel passenger equipment cars, but for the painting of any other full size steel structure of a similar character where protection and finish are desired.

PNEUMATIC CHUCK FOR STAYBOLT DRILLING

BY J. C. BREKENFELD,
Assistant Machine Shop Foreman, St. Louis & San Francisco, Springfield, Mo.

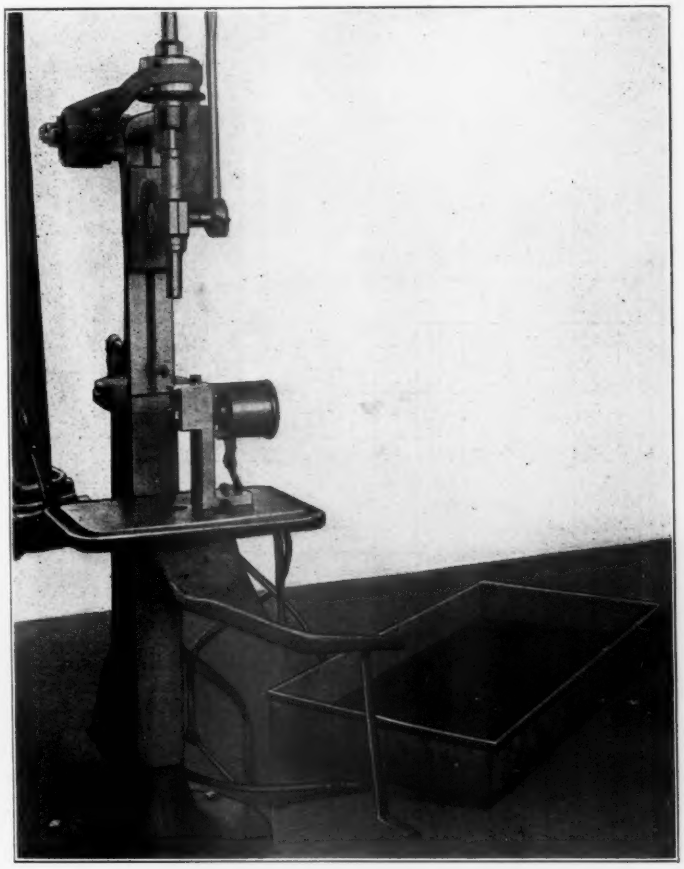
The illustrations show a device that was designed to reduce the breakage of drills to a minimum and increase the output of the machines in drilling 7/32-in. holes, 1½ in. deep, in staybolts



Details of Pneumatic Chuck for Drilling Staybolts.

for locomotive boilers, in order to comply with the government requirements. Before the introduction of this pneumatic chuck, the method used was that of screwing a hardened tool-steel cap on the staybolt for a drill guide, and holding the bolt in a small chuck with a V cut on one of the sides; a handle was provided to hold the bolt in the V of the chuck. The breakage of drills by this method was excessive, there often being as many as six or eight broken per day in drilling from 175 to 300 bolts on a machine.

Having available three drilling machines of one type, it was decided to place them close together and equip them with pneumatic chucks. Heavy galvanized-iron chutes were placed underneath the tables to convey the bolts and lubricating liquid to a pan on the floor, so located as to serve all three machines. A small geared circulating pump was placed at the back of the base of one machine and belted to the smallest driving pulley cone. A ¼-in. pipe was led from the pump to each machine, just back of and through the machine column to the height of the top of the chuck, and a ⅛-in. pet cock was used to regulate the flow of lubricant. In the operation of the chuck air is admitted behind the piston, which draws in the clamp *A*. A staybolt having been previously placed in this clamp, the action of the air pressure holds it firmly in the V-shaped notch in the chuck body *B*. The bolt is thus centered under the small hole in *C*, through which the drill is guided.



Pneumatic Staybolt Chuck Applied to a Drill.

The original feed handles on the machines were only 12 in. long, but these were increased in length to 18 in. and made of ½-in. gas pipe so as to be light enough for the counterbalance spring of the spindle to raise the drill out of the staybolt after the right depth had been drilled. This leaves the operator's right hand free to release the air chuck, and the left hand free to place another bolt in the chuck. The drilled bolt, on being released, falls through the table and follows the chute to the pan on the floor, from which the bolts are delivered to the stores department by laborers as often as the pan requires to be emptied.

With these changes and the machines speeded to 800 revolutions per minute, the output of each machine was increased to

about 800 bolts per day of nine hours, and the breakage of drills was reduced to only one or two each day, sometimes none being broken. The average drilling time is thirty seconds per bolt.

DIAGRAM OF MACHINE TOOL OPERATION

BY L. R. POMEROY.

The accompanying diagram permits information to be quickly and accurately obtained in an investigation of the amount of metal removed by a machine tool, as well as the horsepower required, when it is operating under various conditions of cuts, feeds and speeds. The scale at the bottom of the left half of the diagram gives the depth of cut in inches, which will be one-half of the reduction in diameter in the case of lathe or boring mill work, and above it are diagonals marked for various feeds from 1/32 in. to 3/16 in. The combination of the depth of cut and the feed will, of course, give the area of the cut in square inches and this is shown in the scale at the center of the table. In the right half of the diagram are shown the cutting speeds from 10 to 120 ft. per minute. The area of the cut multiplied by the cutting speed will give the cubic inches of metal removed a minute. This is shown on the bottom scale of the right-hand half of the diagram. Directly below this is given a scale of the horsepowers required for doing the work on three different materials, viz.: cast iron, wrought iron and steel, and steel tires. This horsepower indicates the size of the motor required on the machine for the work.

This diagram can, of course, be used in various ways. The example shown by the dotted line indicates that a machine working with a ½-in. depth of cut and a ⅛-in. feed and running at 80 ft. per min. cutting speed will remove 60 cu. in. of metal a minute. This would require 24 horsepower if the metal was cast iron, 36 horsepower if of wrought iron or steel, and 60 horsepower if steel tires were to be turned. To indicate another way of using the table, we will assume that a lathe has a motor which will deliver 20 horsepower for the length of time that the operation requires. Assume that a cast-iron piston head, 24 in. in diameter, is to be turned. The machine is assumed to be fitted with speed changes such as will allow a speed of 95 revolutions a minute of the spindle to be obtained, which will give a cutting speed of about 60 ft. per minute. If the diameter is to be reduced ¾ in. the depth of cut will be ⅜ in. Referring to the table, it will be seen that 20 horsepower for cast iron is equivalent to the removing of 50 cu. in. of metal a minute. Following on the line through the point 50 up to the diagonal line marked 60 ft. per minute cutting speed and then directly across until the vertical line from ⅜ in. depth of cut is intersected, it is found that a feed of about 3/16 in. will be required to develop the full power of the machine. Other methods of using the table will readily suggest themselves to the foreman or operator.

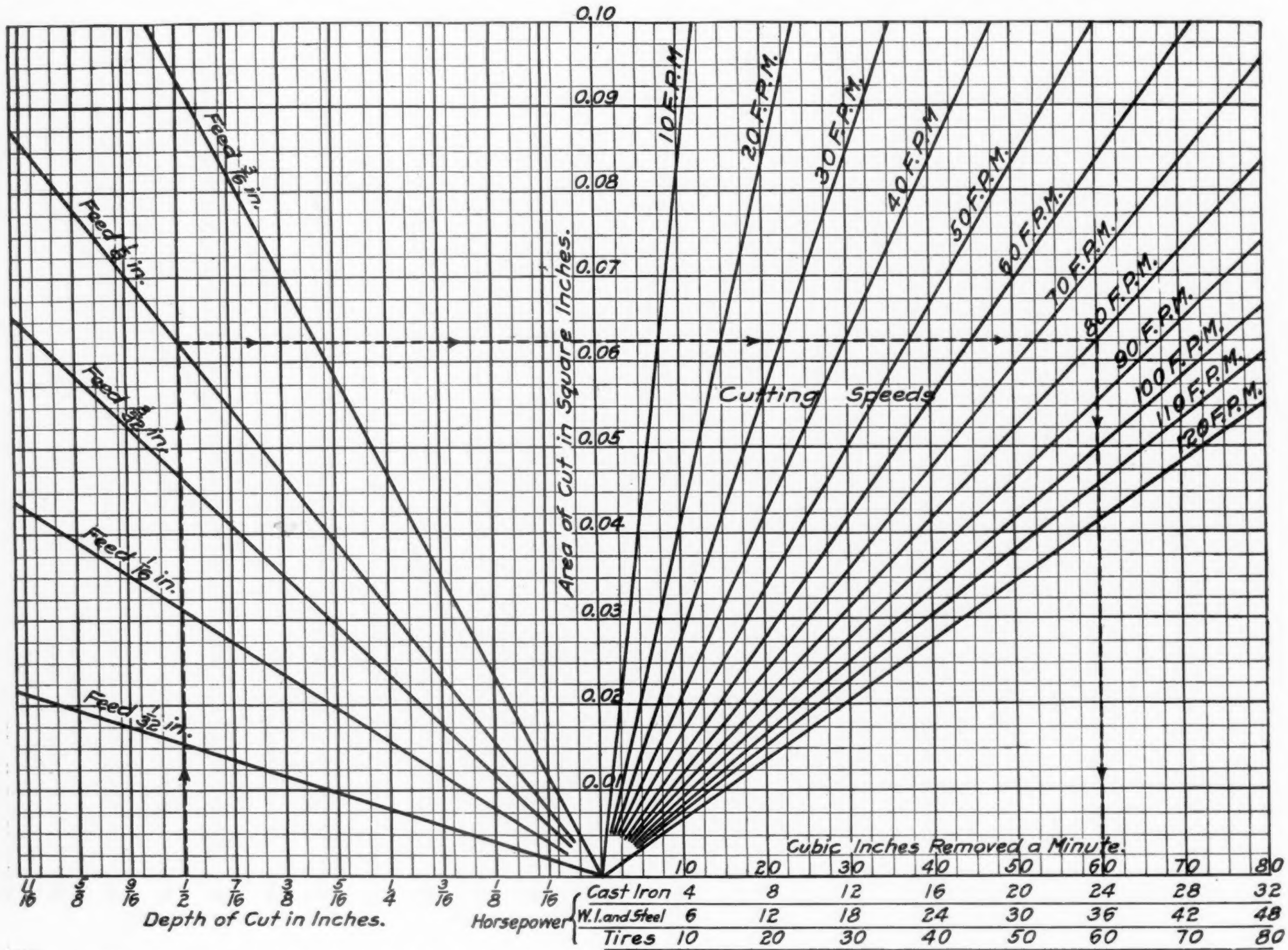


Diagram Giving the Relations of Feeds, Cuts, Cutting Speed, Metal Removed and the Horsepower for Machine Tools.

SUBWAY FOR GENOA, ITALY.—Genoa is confined to a comparatively narrow territory, between the mountains and the sea, and can only grow at the two ends. Two engineers, E. Ravà and S. Cattaneo, have planned a subway and elevated railway to serve it, from a suburb on the west to one on the east, a distance of a little over 6 miles, about three-fourths of which will be underground. The cost is estimated at $5,000,000.

Apprenticeship on the Illinois Central

Both the Shop Apprenticeship Methods and the Co-Operative Plan Possess Unique Features.

A general system of apprentice instruction was established on the Illinois Central and Central of Georgia last July under the direction of the Educational Bureau, a department established on these roads in 1911 for the purpose of providing free instruction to the employees who desired to educate themselves further in their respective fields of railroading. Although these roads have employed apprentices before this time, there were no instruction classes held except at Water Valley, Miss., and Vicksburg.

The Educational Bureau having become thoroughly established was in a position to handle the apprentice instruction in an effective manner, and under the direction of D. C. Buell, chief of the bureau, nine schools on the Illinois Central and one on the Central of Georgia were in full operation within two months' time, the lesson papers being prepared by the Bureau. The handling of the problem in this way makes it possible to operate these schools at a reasonably low cost. The following table shows the operating cost for the two lines:

Road.	Miles.	Number of schools.	Apprentices enrolled.	Cost per year.	Cost per school per year.	Cost per apprentice per year.	Cost per mile of road per year.
I. C.	6,127	9	365	$9,000	$1,000	$24.66	$1.47
C. of Ga.....	1,914	1	75	1,500	1,500	20.00	.78

After a careful study of the situation it was decided to have 30-minute class sessions, beginning at 7 o'clock in the morning; this allows ten classes to be handled each morning. In all but the Burnside shops at Chicago, it is possible to finish the class work before noon. This length of session was chosen because it was believed that the apprentice would be able to assimilate more than if required to spend a longer time in the class room. The boys come to class knowing that the period is short, and that they must pay attention, because there is barely time to get what they want. They go away still fresh and interested, and wanting more instruction rather than being satiated with what they have tried to absorb.

A second consideration was that by having half-hour class periods the instruction work is more flexible, and at the smaller shops the classes need not consist of more than three or four boys; at the larger shops the maximum number in a class would not be over eight or nine. In this way the boys may be kept in classes which suit their progress, and may be given practically individual instruction.

There is a third feature that is also important from an economic standpoint, and that is that with the exception of the very largest shop, the instructor is through with his instruction work at noon each day, and can spend the afternoon doing special work for the shop officers, or in organizing special night classes for the journeymen and handymen in the shop who want instruction. These evening classes are offered to the men free of charge, and in some places they are very well attended.

The next consideration was the relationship of the apprentice instructor to the shop. It was especially desired not to take the control of the apprentice boy away from the shop organization, and it is thoroughly understood on the Illinois Central and Central of Georgia that the apprentice instructor has no authority over, or any concern in, the boys' shop work. The master mechanic, shop superintendent, or general foreman, is, of course, naturally interested in his apprentice boys, and will have a special desire to teach them to become efficient journeymen, but if, through the establishment of an arbitrary apprentice instruction organization, the control of the apprentice boys in the shop is taken away from these men and turned over to the apprentice instructor, it naturally creates a condition where the shop officers lose a certain amount of interest in the shop work of the boys, which is not counteracted by the work the apprentice instructor is able to do in the shop. The shop officers, therefore, continue to have the same jurisdiction and responsibility for the boys as before apprentice instruction was established. They are responsible for the education of the boys in the shop, and the apprentice instructors, under the direction of the Educational Bureau, are responsible for the class work only. This system of organization has worked out successfully, and the shop officers have taken a renewed interest in the whole apprentice question, having arranged for a shop foreman or demonstrator to have special charge of the boys in the shop. The fact that the apprentice instructors do not arbitrarily step in and take the apprentice away from the control of the foreman is considered one of the chief advantages of this system.

Class Instruction.

No mechanical drawing is taught in the apprentice schools during the first year and a half or two years of a boy's apprenticeship. It is not the aim of the apprentice class work to make draftsmen, but to make more efficient shopmen. The apprentice boy needs to learn to read working drawings; he needs to learn to make a shop sketch quickly and accurately, but he does not need to be a mechanical draftsman to accomplish these results. Consequently, the first work in the shop apprentice classes consists of a series of 85 half-hour lessons on reading working drawings. These lessons have been specially prepared, and the thirty-sixth lesson is an actual shop blueprint.

The lessons in the reading of working drawings are given on alternate days, or three times a week. They are followed by shop sketching lessons, of which there are about 60 in the series. With this schedule the apprentice boys should be able to read any shop blueprint, and to make any necessary sketches in connection with their work at the end of the 145th lesson. Following the instructions in these two subjects, which is given to all classes of apprentices, will be lessons in shop practice, arranged according to the different trades that the apprentices are learning.

Such boys as desire to take mechanical drawing will be allowed to do so in the last half of the last year of their apprenticeship, although any of the boys who are particularly anxious to qualify as draftsmen may take up the regular mechanical drawing course of the Educational Bureau on their own time during any period of their apprenticeship.

The alternate days not given up to the course of lessons just described, are assigned to the study of arithmetic and general mechanical subjects. The first year apprentices are started out with lessons in addition, subtraction, multiplication, division, etc. Those who are qualified in these subjects simply take the lessons as a review and quickly work themselves up to a higher class. These lessons are continued with practically no interruption through decimals, and then through higher mathematical subjects, such as square root, cube root, formulas, geometry and trigonometry; interspersed between the latter series are other lessons of a practical nature on mechanical railroad subjects. For instance, the Educational Bureau's unit on "Locomotive Boilers" is read and discussed in class, and the class may meet in the shop at some dismantled locomotive to complete their study of this subject. Following this some other paper on the locomotive is taken up. The locomotive chart is studied to familiarize the boys with the names of all the parts of a locomotive. The car chart is studied in a similar way by the car shop apprentices. Other of the Educational Bureau lessons are used in a similar manner to give the boys as broad a general knowledge as is possible in the time allowed.

During the study of the lessons in the reading of working

drawings the instructor, who is equipped with a T-square, triangles and a compass for use on his blackboard, draws some of the figures in the lessons, explains some of the simple principles of geometrical drawing, etc. The boys also go to the blackboard and make freehand drawings of many of the objects illustrated in the lessons, to make sure that they are understood. In this way the student receives a fairly good elementary knowledge of sketching while learning to read working drawings, and all through the lessons on this subject and sketching the student is learning the fundamental principles of mechanical drawing so that on the completion of the course in the reading of working drawings and sketching lessons it will not be difficult to make a fair draftsman of him.

In a similar way the shop practice covering each of the drawings that a boy receives in class is outlined and covered in connection with the reading of the drawing, so that a boy when taking the first actual blueprint, which is lesson 36, does not look at it simply as a cellar bolt, but is told what a cellar bolt is for, how it is made, what kind of a machine it is made on, what kind of material is used, how the stock is obtained, what is done with the finished stock, etc. This principle is followed through in all of the lessons.

CO-OPERATIVE PLAN.

A short time after the apprentice schools had been established the co-operative plan was started on the Illinois Central at McComb, Miss., by which high school students are received as apprentices in the shop while they are attending school, the time being equally divided between the shop and the school. This plan is similar to that originated by Dean Herman Schneider of the University of Cincinnati, and while there have been similar co-operative plans between high schools and shops it is believed that this is the first such plan adopted between a railroad shop and a high school.

The reason for starting it was rather unique. Professor H. P. Hughes, of the McComb city schools, wanted a manual training department to help make the high school more attractive to the boys. He had a rather peculiar experience in the case of two boys that clearly demonstrated the necessity for such a department. Two chums were graduated from the eighth grade at the same time; one went to work in the railroad shop as an apprentice, while the other was persuaded to continue on through the high school. By the time this boy was graduated the other, having served his apprenticeship, was a journeyman at his trade, and was earning 39 cents an hour. The high school graduate, seeing no other opening, applied for work at the shop, and the best that could be given him was a first year apprenticeship at 12 cents an hour. It happened that this high school graduate at 12 cents an hour was put to work as the helper of the chum, a journeyman earning 39 cents an hour. Parents and children alike in McComb could only see, after this experience, the difference of four years in time and 27 cents an hour in money in favor of *not* going to high school, and it was to overcome this condition that Professor Hughes asked the Illinois Central for aid.

The details of the plan were handled by Mr. Buell, chief of the Education Bureau, and it was arranged for the boys to spend alternate days in the shop. Two boys constitute a unit in the shop and in the school. One boy reports to the shop and works as an apprentice Monday, while the other boy of the unit is in school. Monday afternoon, after school hours and before the shop closes, the school boy hunts up his partner in the shop, and finds out what he is doing, so that he can report for work at the shop Tuesday morning and let his shop partner attend school Tuesday. The boys alternate thus each day, so that the unit always represents one apprentice boy in the shop and one student in the school. Experience proves that there is practically no confusion in the shop due to this method of alternating the apprentice boys; and so far no change has been required in the present school program.

The railroad accepts as a student on the co-operative plan any public school student 16 years of age, or over (in accordance with state laws), who shall be recommended by the proper school officer. There are few formalities connected with the plan. The student signs the same form of apprentice indenture as any other apprentice boy, who applies for work at the shop and is accepted, would sign. Each boy must agree to be faithful and diligent in both his shop work and his school work, and respecting the discipline of the shop while at the shop. Unsatisfactory work in the shop or school will be sufficient cause to bar a student from further participating in the benefits of this plan.

The regular four years' high school course, when taken on the co-operative plan, contemplates the student working in the shop during the summer months when the school is not in session. Taking this into consideration it may be seen that under this plan the high school student at graduation will have worked about two years and five months actual time in the shop, but the Illinois Central allows three years' time on the apprenticeship period of every high school student who graduates under this plan, so that on graduation the co-operative student will have only one year more of apprenticeship to serve before becoming a journeyman.

This plan proves successful in practice because of the fact that every such boy becomes a responsible factor in the every day work of his community. It is up to him to be on time at the shop and to know what he must do; it is also up to him to study with his partner and keep pace with his class. In addition to this the boys are paid regular apprentice rates for every hour they work in the shop, so that as wage earners under shop discipline they begin to grow into useful manhood. The sense of responsibility, the fact that wages are paid for work done, and the broader insight into practical affairs that the boys obtain through this plan, all unite in giving them a clearer understanding and a higher appreciation of the value of their school work. Experience proves also that under this plan they are able to do with ease twice as much in school as the average high school student.

There are only two really good reasons why a boy in good health leaves school before he graduates from high school. The first is that he must earn money for his own support or the support of his parents. The second is that the school does not interest him—he wants to get out in the world, to "get to work," to be earning some money. The co-operative plan nullifies both of these reasons for a boy leaving school, and leaves practically no excuse for parents interrupting a boy's schooling before he graduates from the high school, for the reason that a high school boy can earn from $15 to $20 a month while going to school and working on this plan, and for the added reason that his desire to go to work is fulfilled, his desire to earn money is fulfilled, and the school work instead of being drudgery is a welcome interruption on alternate days from the hard work of an apprentice in the shop. This plan does not appeal to boys who are lazy or who have a yellow streak in them, but it does appeal most strongly to the majority of boys who now want to leave school before graduation.

The adoption of this plan has developed another interesting feature, and that is that without exception at the places where it has been started there have been one or more boys in the shop who have not completed the high school course, who have gone back to school under the co-operative plan, continuing on their term of apprenticeship, and at the same time arranging to complete their high school education; and in more than one instance the co-operative plan has appealed to them so strongly that boys who had left school in the first year of high school with no intention of getting any further education, are now going back to school and are planning to go on at the completion of their high school work to a technical school which offers co-operative education.

This plan costs the railroad company practically nothing, but it is giving the company a considerably higher class of appren-

tices. In a similar manner the plan costs the community which adopts it nothing, but it makes the high school work much more effective, and enables many boys, who would otherwise leave school, to continue their schooling and become high school graduates, while at the same time they are able to pay their way from the money they earn in the shop, and are learning a trade.

Soon after this plan was well started at McComb the same opportunities were offered at other shops, and the plan is now in effect at Centralia, Ill., Clinton, Ill., Waterloo, Ia., and at Birmingham, Ala. While it has only been in operation for a short time, it has been so well received by both the students and the local school authorities that it bids fair to extend rapidly.

SHOP ORGANIZATION.

The shop instruction and the class room work are in no way connected to each other, the educational work being directly controlled by the Educational Bureau, and the shop instruction directly controlled by the mechanical department officials. The mechanical department is represented by F. W. Bason, who, as supervisor of apprentices, follows up the work of the apprentices in the shop and has general charge of the apprentices from the mechanical department standpoint. The apprentice is hired by the local mechanical department officers, who, after receiving a report of his educational qualifications from the local apprentice instructor, pass on his character and general qualifications as an apprentice.

The following schedule has been arranged for the transferring of apprentices from one class of work to another, so as to give the boy a general knowledge of all the different classes of work pertaining to his particular trade:

MACHINISTS.

	Months.
Drill press (large and small)	2
Lathe (bolt lathe first; then general)	7
Shaper	2
Planer	2
Slotter	2
Boring mill	3
Work above running board, consisting of hand rails, pops, whistles, boiler mountings and all similar work	4
Frames, shoes and wedges, wheeling engines, putting up spring rigging, expansion gear, removing and applying cylinders, etc.	4
Applying pistons and steam chests, putting up motion work, lining guides, etc.	4
Vise work on rods, etc.	4
Vise work on motion work, pistons, crossheads, etc.	5
Tool-room work, handing out tools, running machines such as tool and drill grinder, lathe, milling machine, etc.	4
Vise work on tools to consist of general repairs to tools of the various departments, die sinking, etc.	5
Total	48

When the apprentice is not placed in the tool room he is placed in the air brake department for the following experience:

	Months.
Overhauling and applying brake rigging, air pumps, lubricators, engineer's valves, injectors, steam and air gages, gage cocks, pops, whistles and all work handled in this department	9

As it will be necessary to have the apprentices in the roundhouse machinery repair gang, and on the surface or laying-out table, the time allotted to these departments is as follows:

Roundhouse from six months to one year; machinery repair gang from two months to six months; surface table from one to three months.

Credit is given the apprentice for experience and time spent on this class of work, and he is exempt from serving any time on the regular schedule on work of a similar nature.

BOILER SHOPS.

	Months.
Heating rivets, scaling boilers, and general helping on light work, punch and shears	6
Ash pan and netting work; also as much sheet iron work and miscellaneous light boiler work as possible	10
Tank work, such as patching, riveting, applying angles, etc.	6
Flue setting	6
Firebox work, reaming and tapping staybolt holes, setting and cutting off staybolts, etc.	8
Working with boilermaker on general work, such as flanging, riveting, applying new sheets, bracing and staybolt work	6

The last six months to be spent on work either under the instruction of the layer-out or working on general boilermakers' work with helper and handymen, the apprentice to be in full charge of work. The work to consist principally of patches, half side sheets, door sheets, back and front flue sheets, smokebox extensions, smokebox liners, and general boilermakers' work.

In shops employing a sufficient number of boilermaker apprentices, one apprentice to be kept with the layer-out, and as one apprentice is retired, another to be ready to take his place.

BLACKSMITH.

	Months.
Running steam hammer	6
Heating bolts	3
Helping on small fires (light work)	6
Running bolt header and forging machines	3
Helping on tool fire	6
Light work on fire with helper	8
Heavy work on fire not requiring any particular skill	10
Working on fire, all classes of work, filling the place of absent blacksmiths and doing general blacksmith work	6
Total	48

The last year of the blacksmith apprentice work consists of general blacksmith work, working on frame fires, heavy work under the steam hammer, such as drawing out, forging billets, piston rods, equalizers, main and side rods, etc., and such other work as will familiarize the apprentice with handling iron under the large hammer. He is also given an opportunity to operate the large up-setting machine.

TIN AND PIPE SHOP.

	Months.
Helping on pipe work	10
Injectors, lubricator pipes and copper pipes in cab	10
Air brake pipes	6
Jackets and sheet iron work	4
Tin roofing, headlights, classification lamps, lanterns, oil cans and general light tinsmith work	6
General pipe and tin work	12
Total	48

CAR DEPARTMENT.

Carpenter Shop.

	Months.
Making boxes, etc.	6
Bench work	6

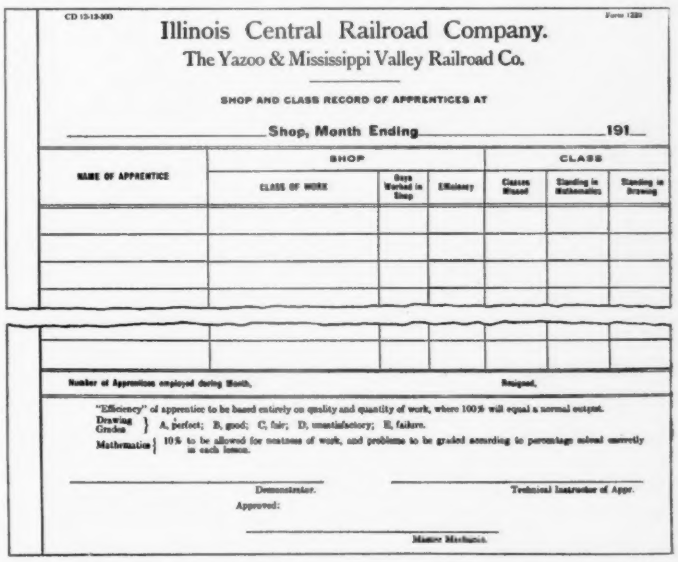
Passenger Shop.

Stripping, etc.	6
Platform work	6
Body work	6
Inside finish and trimming	6

Freight Shop.

All around car work	6
Office work in car department office on defect cards, etc.	6
Total	48

The following individual monthly report is made out by the shop demonstrator and the educational instructor, and is approved by the local master mechanic:


CD 12-12-300 Form 1220

Illinois Central Railroad Company.

The Yazoo & Mississippi Valley Railroad Co.

SHOP AND CLASS RECORD OF APPRENTICES AT

________ Shop, Month Ending ________ 191__

NAME OF APPRENTICE	SHOP			CLASS		
	CLASS OF WORK	Days Worked in Shop	Efficiency	Classes Missed	Standing in Mathematics	Standing in Drawing

Number of Apprentices employed during Month, Resigned,

"Efficiency" of apprentice to be based entirely on quality and quantity of work, where 100% will equal a normal output.

Drawing Grades } A, perfect; B, good; C, fair; D, unsatisfactory; E, failure.

Mathematics } 10% to be allowed for neatness of work, and problems to be graded according to percentage solved correctly in each lesson.

Demonstrator. Technical Instructor of Appr.

Approved:

Master Mechanic.

Form Used for Monthly Shop and Class Record of Apprentices.

This report is made in duplicate, one copy being sent to Mr. Buell, chief of the Educational Bureau, and the other being held at the local shop. A second form is made out monthly by each shop for the office of the general superintendent of motive power, showing the average efficiency in the shop and class room of all apprentices in each trade for the first, second, third and fourth year apprentices. From this form a summary is made, with the same headings, but with the totals from each shop so that a comparison may easily be made. The following table

gives the classified list of apprentices on the Illinois Central system:

APPRENTICES PER TRADE PER SHOP.

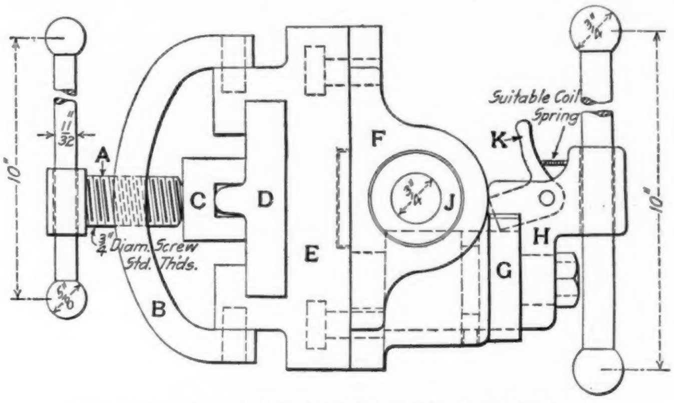
	Machinists.	Boilermakers.	Blacksmiths.	Tin and pipe.	Painters.	Carpenters.	Found.
Burnside Shops	62	10	3	16	1	17	..
Memphis, Tenn.	26	3	..	..	1	..	..
Vicksburg, Miss.	20	6	2	2	..	..	..
McComb, Miss.	20	5	2	..	5	5	5
Water Valley	22	1	3	2	2	2	..
Waterloo, Ia.	13	9	2	..	..	1	..
Paducah, Ky.	32	6	1	3	2	1	..
Centralia, Ill.	13	2	..	2	..	..	..
Clinton, Ill.	24	5	..	1	..	..	..
Mattoon, Ill	6	2	..	1	..	..	..
Freeport, Ill.	5	2	..	..	..	..	..
Mounds	2	..	..	2	..	..	..
East St. Louis, Ill.	7	..	..	..	..	..	..
Total per trade	252	51	13	29	11	26	5
Total entire road	387						

MACHINE FOR DRILLING TELL-TALE HOLES IN STAYBOLTS

BY PAUL R. DUFFEY.

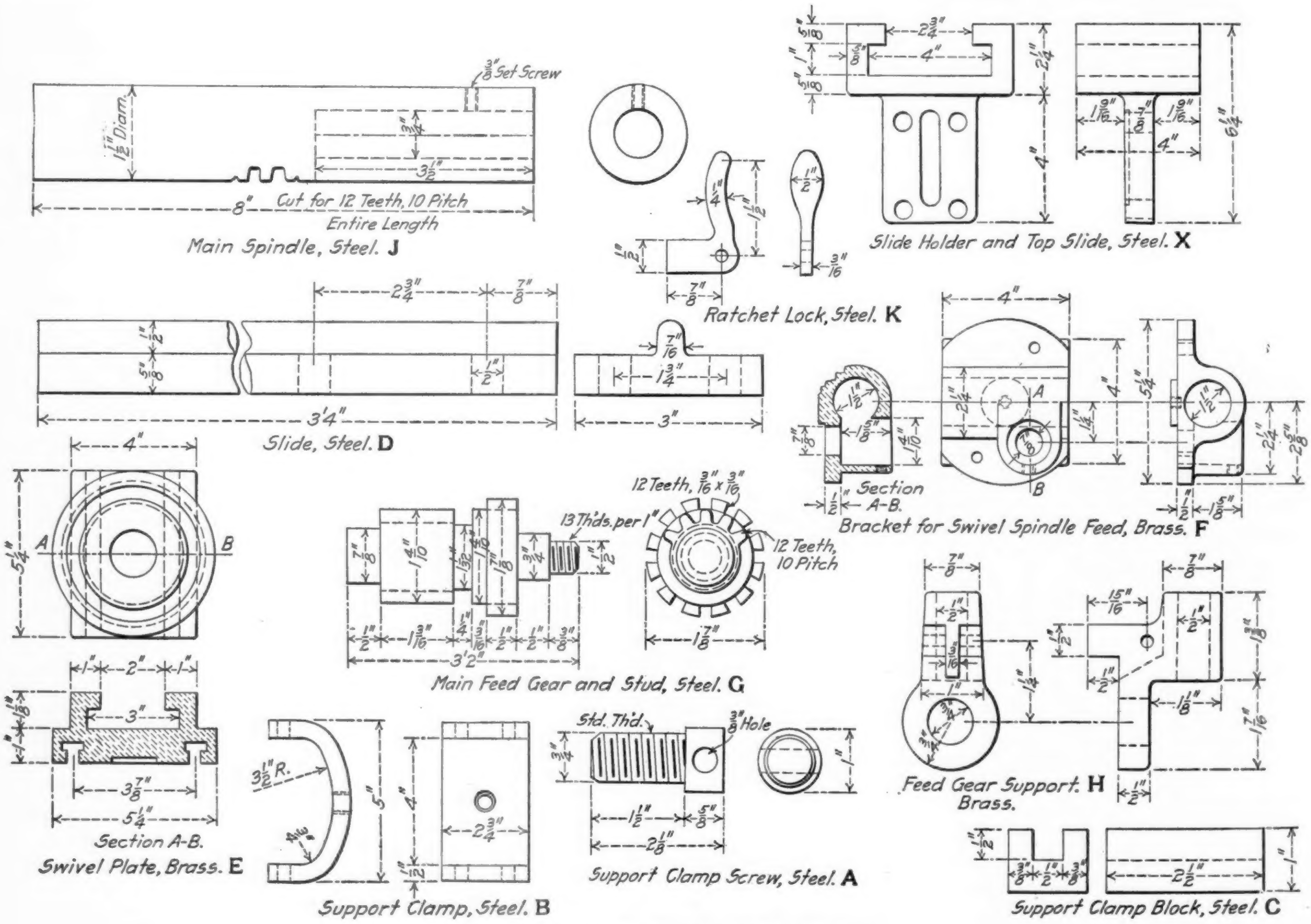
It has been the general practice to drill tell-tale holes in staybolts before applying the bolts and to countersink the ends sufficiently to prevent closing the holes when riveting. A number of shops applied bolts without drilling, but when the drilling was done later the depth of the holes did not conform to the present standard, and in consequence had to be redrilled to standard.

In order to drill the bolts to the proper depth after they are applied, the machine illustrated here was devised. It permits of accurately drilling holes in staybolts at any angle after they are in position in the firebox. The whole machine is supported by a suitable flat bar supported at the ends by upright pieces of angle iron which are fastened to the floor by lag screws. This frame is braced to the backhead of the boiler and the slide holder *X*, placed on the flat bar, supports the slide *D*.



Apparatus for Drilling Tell-tale Holes in Staybolts.

The machine is clamped in any desired position on the slide *D* by means of the support clamp *B*, support clamp block *C* and screw *A*. The swivel plate *A* has a bracket *F* for the spindle feed, attached to it in such a way that it may be turned to any position and the main spindle *J*, which holds the drill, passes through this bracket. The feed gear *G*, which has teeth engaging with those on the main spindle *J*, is controlled by means of the handle in the feed gear support *H* and the ratchet lock *K*. The power for operating the drill is supplied by an air motor. This device is in use at the Portsmouth, Ohio, shops of the Norfolk & Western, where 1,800 holes have been drilled by it with six 3/16 in. drills.

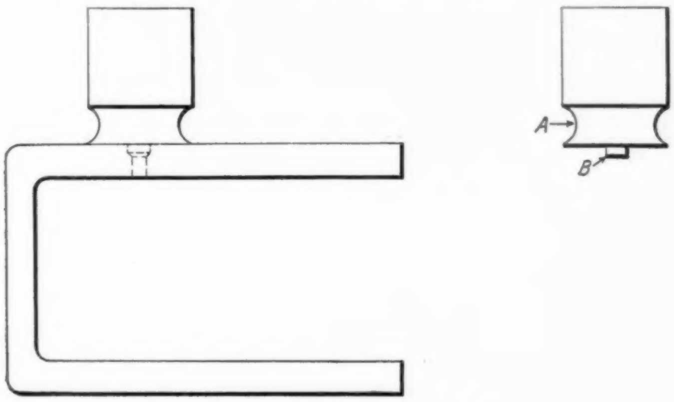


Details of Machine for Drilling Tell-tale Holes.

WELDING OIL CUPS ON ROD STRAPS

BY E. L. DUDLEY.

The drawing shows an oil cup machined, ready to weld on the strap. It is made from a piece of round iron of the proper size, chucked in a lathe where thimble *B* and groove *A* are formed. The strap is counterbored the size of thimble *B* to receive the oil cup. The thimble is about ¼ in. long, and the counterbore in the strap is just deep enough to allow the cup to rest flat on the strap. The cup and strap are then delivered



Oil Cup Prepared for Welding to Strap.

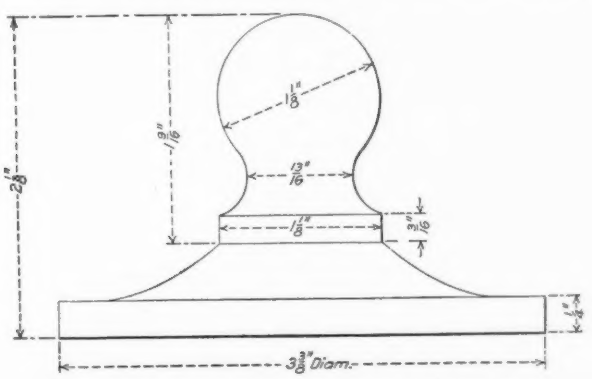
to the blacksmith shop, where both are brought to a welding heat and the weld is made in the usual manner. The groove *A* is to help the blacksmith in using his tools. After welding, where no special tools are in use for the purpose, the cup may be easily finished by chucking the strap in a lathe.

SMALL FACE PLATE FOR AIR BRAKE WORK

BY F. W. BENTLEY, Jr.,
Chicago & North Western, Huron, S. D.

Face plates used in connection with air brake repair benches are often few in number and in poor condition, two or three men sometimes using the same plate, with the result that it gets but little care.

The plate illustrated is made from an old reversing cylinder cap from a Westinghouse 8 in. air pump. The threaded portion of the cap can be used to hold it in the lathe chuck jaws



Face Plate Made from Reversing Cylinder Cap.

while the handle is being turned up. By turning the cap around and protecting the finished portion with copper strips between it and the jaws, the threaded portion may be turned off and the part used as a face may be gone over and trued up. A lathe in good condition can turn out a very accurate plate. The plate should be kept in a small tin box, the bottom of which should be covered with a flannel rag soaked in oil. By using these old caps each repair man may have a face plate of his own, and they will be found useful in spotting slide valve feed valve valves, flat faced triple valves, rotary seats and for a great variety of other work.

SMITH SHOP KINKS

BY C. L. DICKERT,
Assistant Master Mechanic, Central of Georgia, Macon, Ga.

WELDING JAWS ON BRAKE CYLINDER PUSH RODS.

The jaws for the brake cylinder push rods may be made on a forging machine at a little more than one-half the cost of doing the work by hand. The dies shown in Figs. 1, 2 and 3

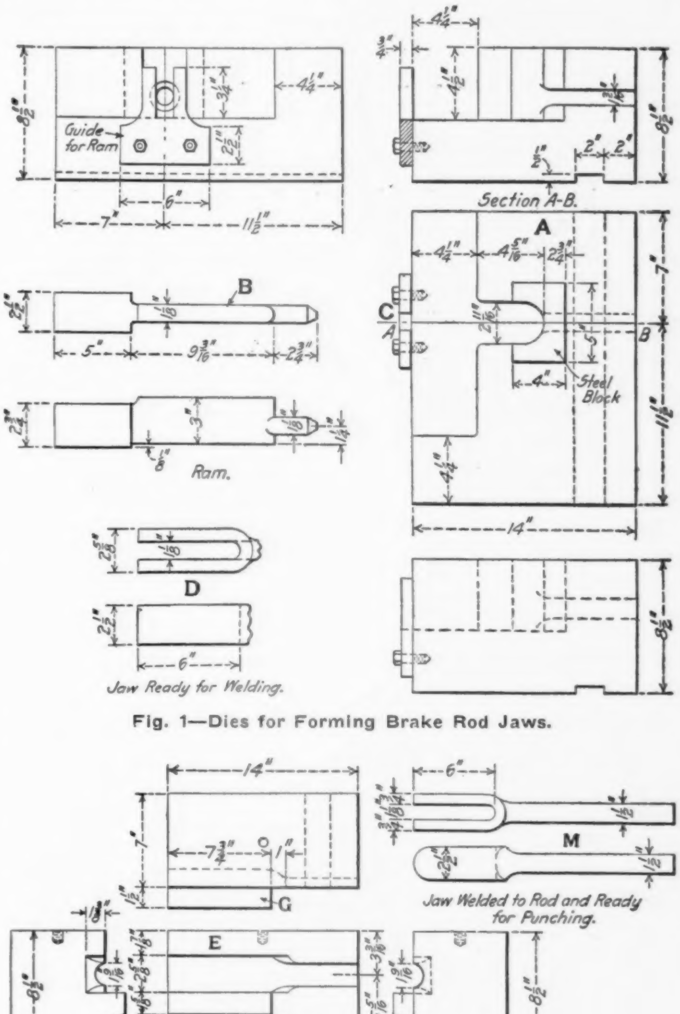


Fig. 1—Dies for Forming Brake Rod Jaws.

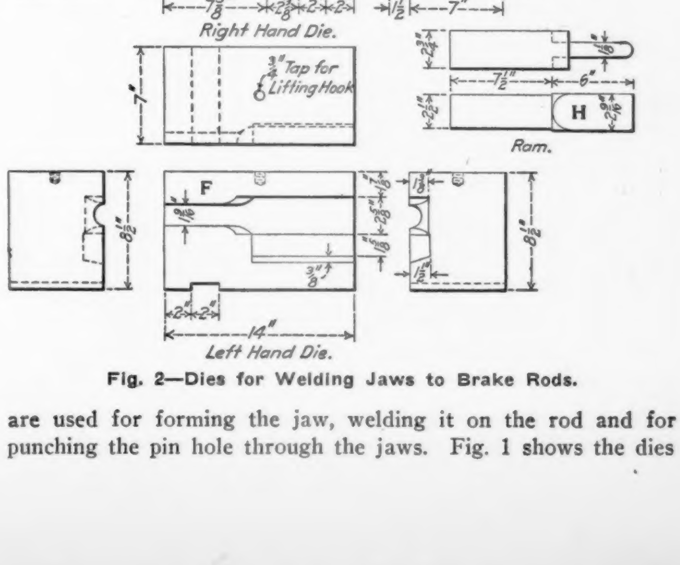


Fig. 2—Dies for Welding Jaws to Brake Rods.

are used for forming the jaw, welding it on the rod and for punching the pin hole through the jaws. Fig. 1 shows the dies

used for forming the jaws. A hole is punched through bottom of the jaw to receive the end of the push rod. A bar 2½ in. wide by ¾ in. thick is placed in the die *A*. The ram *B*, which punches the hole and at the same time bends the jaw, is steadied by the guide *C*. The finished jaw is shown at *D*.

The end of push rod is swaged down to fit the hole in the jaw, and both of them are welded together by the dies shown in Fig. 2. The female dies are made of the two blocks *E* and *F*. The block *E* has a projection *G* which fits in a recess in *F*.

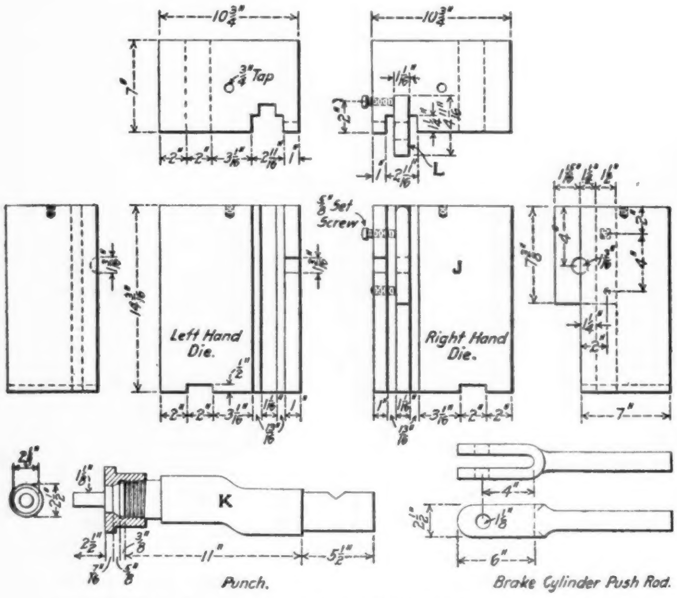


Fig. 3—Dies for Punching Pin Holes in Brake Rod Jaws.

The ram *H* enters between the forks of the jaw and welds it to the rod. The rod with the jaw welded on is shown at *M*.

The pin hole is punched in the jaws by the dies shown in Fig. 3. The die *J* is provided with the spacing plate *L* which fits between the jaws and keeps them from bending while being punched. The punch *K* has an adjustable head, so that different size punches may be used.

UPSETTING AND PUNCHING COUPLER YOKES.

Dies for upsetting and punching coupler yokes are shown in Fig. 4. The finished yoke is shown at *A*; the ram for upsetting the ends is shown at *B*, and the punch and receiving dies are shown at *C* and *D*. The receiving dies are cored out as shown at *E* to allow the punchings to fall away from the dies. The punching and upsetting is done in a 4-in. Ajax forging machine in one operation, the bending being done in the bending machine shown in Fig. 5. The yokes are completed in three operations and are finished in the smith shop, formerly the holes were layed out and drilled in the machine shop. One operator and a helper can upset and punch 30 yokes in an hour.

AIR BENDING MACHINE.

An air bending machine that may easily be made from scrap material is shown in Fig. 5. The main cylinder is 18 in. in diameter inside. The piston fits in the crosshead that operates

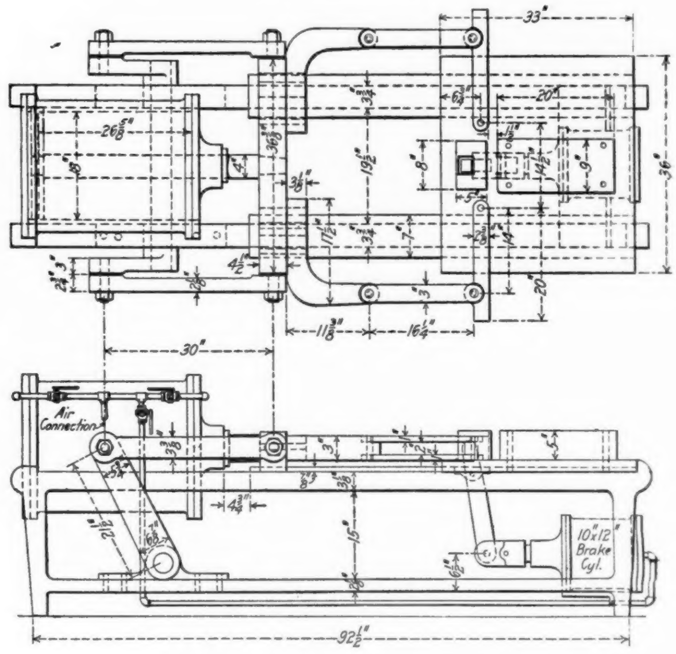


Fig. 5—Bending Machine for Coupler Yokes.

the bending arms through jointed rods. The crosshead is held from twisting, due to the inequality of the load on the bending arms, by the rocker located under the main cylinder. The 10-in. x 12 in. cylinder at the lower right hand end of the machine operates a clamp which holds the bar that is to be bent, firmly in place.

This machine is used to good advantage in bending the coupler yokes shown in Fig. 4. This machine was designed by Jack Jenkins, of Decatur, Ala., with the exception of the clamping device, which was put on by the writer.

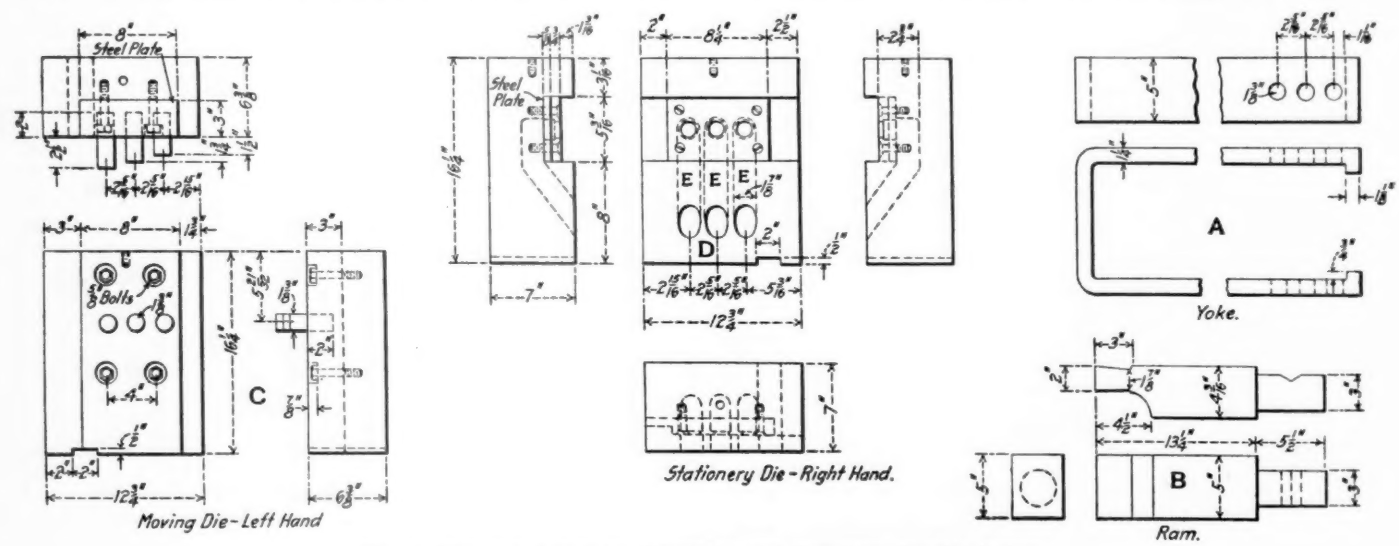


Fig. 4—Dies and Punch for Upsetting and Punching Coupler Yokes.

CAR DEPARTMENT

BOX CAR CONSTRUCTION, AS VIEWED BY A REPAIRER*

BY H. S. FENTRESS,
Foreman Car Department, Norfolk Southern.

During the past few months I have noticed several lots of cars, recently built, which have been equipped with outside metal roofs. This class of roof is a grave mistake. I make this unqualified statement because of personal observation. The first objection is the almost impossible task of keeping the metal protected from the weather. An inspection of roofs turned out during the first half of 1912 will bear out the above statement; consequently the metal left unprotected will soon rust, and in a snort time leaks will develop, causing claims for damaged goods and necessitating the removal of the cars from service for repairs to the roof. Cars doing service near the sea coast for any length of time will suffer in this way quicker than those in service away from the influence of the salt air.

There are, of course, several preparations on the market purporting to be just the thing for metal roofs, but so far as I know, nothing has been found to adhere to the metal satisfactorily. It has been suggested that the roofs remain uncovered until corrosion begins, thus giving the paint something to hold to. This, I believe to be a fallacious idea, for corrosion, having begun its work while the metal was unprotected, continues to eat like a cancer, and under cover of the coat of paint it received too late its work of destruction is not noticed; the first intimation the car department has of the leaky condition of the roof is through the claim agent. Then again, should we persuade ourselves that this suggestion is a good one, it is in a large measure an impractical one, as the owners are unable to keep the cars home, and a certain percentage remain away for many months; there is a possibility of the roof receiving no attention, and of the rust destroying it while the car body is comparatively new.

The short running boards, added to the fore and aft boards, with their saddles constantly bearing on the metal, and the working of these saddles, little as it may be (and there will be some no matter how much attention is given them), causes the metal to wear under the saddles, thus creating leaks difficult to detect, and thereby adding another source of annoyance to the car department and extra work for the claim department.

There are grave defects to be found in the designs of many inside, or covered metal roofs. In a majority of cases the metal is not properly held in position in the groove of the ridge pole to take care of the working of the car body; other designers have secured the metal in this regard, but have omitted to take sufficient care of the lower ends of the sheets, allowing the drip to fall into the joint formed by the side plate and the siding. I have recently tested several of the roofs that were reported leaking to the extent of damaging the lading by water. The test showed that the roof was intact and in the same condition as originally constructed. There was no furring strip on the side plate and the fascia boards were nailed tight to the siding with no space between. The car had not opened, being equipped with metal carlines securely fastened to the side plates, but the water, finding its way through the roof sheathing, ran down to the plate. The roof boards being nailed tight at this point, the water flowed back over the plate and into the car, as well as finding an avenue between the siding and the plate and dropping on the belt rail, and then on the lading. This style of roof shows the defect in construction only in severe rain storms.

*Entered in the Car Department competition, which closed February 15, 1913.

What is badly needed is a roof so designed that the sheets will be held firmly in the ridge pole groove, and the sub-carlines, or parting strips, will be secured at the ridge pole and side plate, while the nailing strips will be bolted to the sub-carlines. The sheet should also flange downward, and be fastened to the siding. A roof bolted together as above suggested would be held more firmly in position. The expense of replacing roofs lost in wind storms is a frequent and considerable item in the charges against the upkeep of freight equipment. A very little added to the cost of application would save a large part of this expense.

There is another advantage for the covered metal roof as compared to the outside metal roof under similar conditions. It is well known that switchmen will take chances on car clearance in the yards, and while the all-metal roof reduces the width of the car at the eaves, the switchman is just as liable to mistake the distance with this type as he is with the wider one. In fact observation has proved to me, at least, that the narrower the car, the more the chances taken. Accidents of this nature happening to an all-metal roof mean torn sheets; the car must go to the repair tracks, which necessitates its removal from service for from one to three days, according to the switching facilities at the point where the accident occurs; the same accident to a covered metal roof would not necessarily remove the car from service, but repairs can be made by inspectors on duty in freight yards, whose business it is to keep loaded cars moving.

Roof conditions are not the only causes that bring about claims for damage to lading. The loose fitting door has contributed its share to this constant leak in the revenue of the operating department. There are more cars being interchanged without doors today than ever before, and the amended M. C. B. rules of interchange will, I believe, increase the number; hence the necessity of insisting on a door that can only be dislodged by a rake or side wipe. Doors lost in transit, owing to a poorly designed hanger, or a track too weak to bear the weight of the door without sagging, represent many dollars that could be saved by adding a very little to the first cost. The door selected should be so constructed as to form a water tight joint when closed, thus protecting the lading from damage during a driving rain storm. The door fastenings on modern cars are very good of their kind, but they do not entirely answer all requirements. Doors on empty cars are allowed to run back and forth at will in switching, thus receiving shocks that tend to impair their usefulness. A device that would secure the doors in an opened or closed position would be beneficial in maintaining their efficiency against the weather, as well as the possible burglar. In other words an automatic door lock is now in order.

I wish to call the designer's attention to another matter that seems to have been overlooked; the inner lining should be carried to the plates on the sides as well as at the ends of the car. The roof and doors may be perfect, and yet in a severe rain and wind storm, damage may occur to the lading in the following manner: The rain will drive through the sheathing, creating a dampness that would ruin lading, which might be particularly susceptible to dampness. It could be argued that this is a rare occurrence. Admitting that it is, the payment of one claim of this nature might more than balance the extra cost to the entire lot of cars, and as the cars deteriorate the chances of the above possibility increases. The extra lining would stiffen the car body, thus enabling it to sustain shocks with less damage.

The steel frame box car that has come to my notice seems to be weak in the end construction. Dressed lumber is a great menace to car ends; therefore that part of the car should be strengthened to meet the sudden shocks incident to the shifting

of the loads. It is a common sight to see steel frame cars on the repair tracks undergoing repairs to the end, the damage being due to a shifting load knocking out the ends. A large part of this damage could be avoided by adding a substantial horizontal metal end brace securely fastened to the side frame of the car. This might be in the form of a T-iron riveted on the outside of the vertical members of the frame and with the sheathing fitting over the flanges of the T. As now constructed, there is no support at the center of the end post and braces, and when the weight of the shifting load is delivered to that point they are not stiff enough to resist, consequently they must bend with the result that the end sill and end plate are twisted. As the cost to repair one of these ends is considerably more than to one of the all-wood ends, the additional expense of the end brace suggested would be insignificant when compared with the amount saved in material and labor, and in keeping the cars in service.

We will, of course, always have cars on the repair tracks, but I believe the designer can, and will, in time, reduce the bad order list to a minimum. This belief is strengthened with the appearance of almost every new design. The progressive spirit is especially noticeable in the underframe, and it would be difficult to suggest any idea that would be an improvement over the latest designs. It is encouraging to note the tendency to get away from the old coupler stops, and their attendant followers and straps, which have always been points for the suspicious scrutiny of the car inspector, and have caused the hold-up at interchange points of many important shipments. It is also gratifying to note the gradual disappearance of the coupler pocket and rivet that have played no small part in keeping the repair track busy, and whose weakness has been the primary cause of many combination defects that the car user was compelled to stand for, when really the defect originated from a weakly designed draft device for which the car owner was responsible, but owing to the combination formed was relieved of by the M. C. B. rules. Happily the designer of the modern draft gear has made the possibility of this condition a thing of the past. The designer is to be congratulated on the wonderful strides made in car construction.

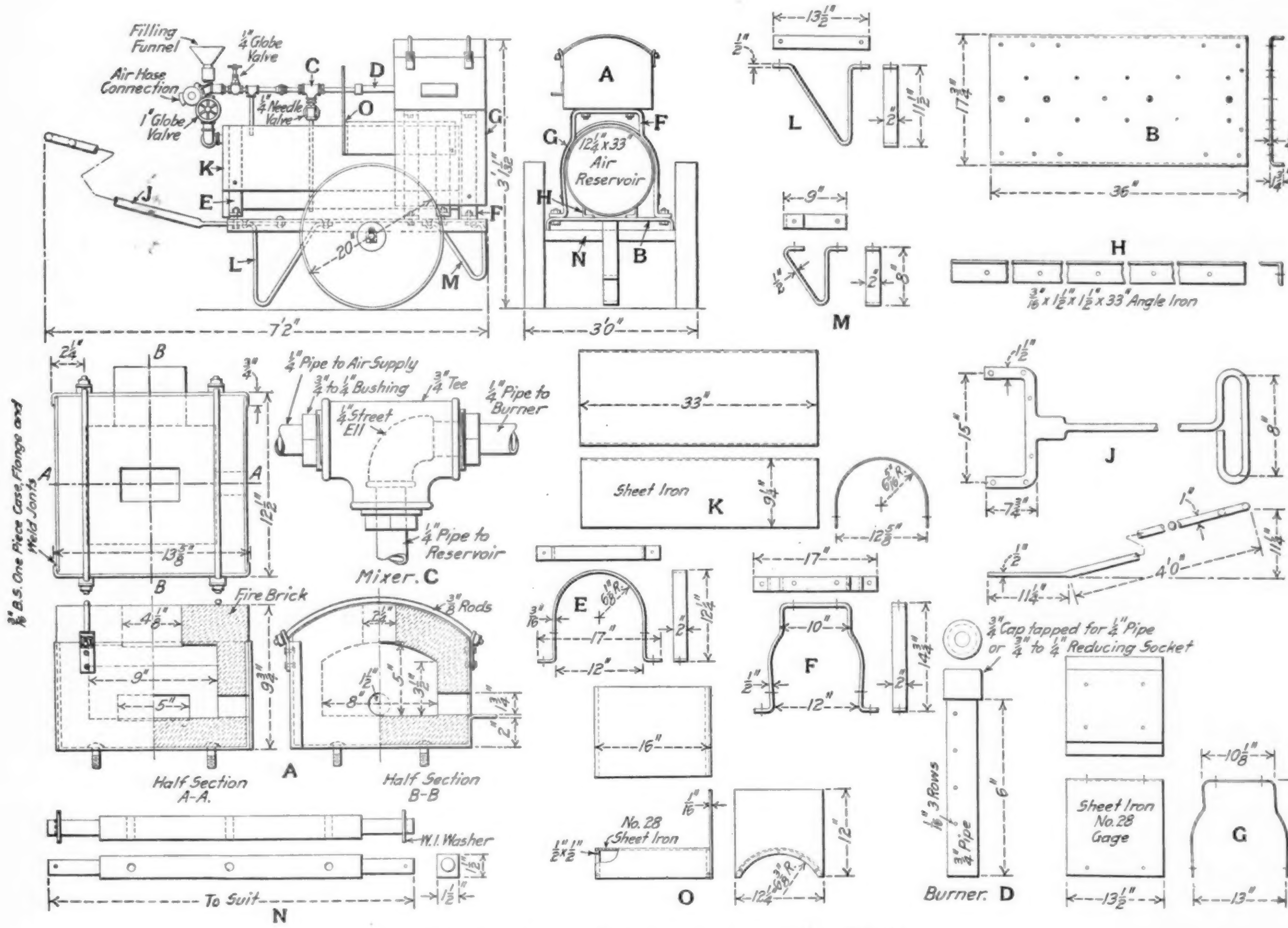
PORTABLE RIVET HEATER

BY LEROY SMITH,
Draftsman, Pennsylvania Railroad, Olean, N. Y.

The portable rivet heater shown in the drawing is simple, easily built and quite economical in operation. It was designed originally for use in the freight car repair yard, but on account of its light construction and the ease with which it can be moved about it is useful for other classes of work.

The wheels are about 20 in. in diameter and are of any suitable pattern; the axle is made to suit. The bed is made of ¼ in. boiler or tank plate, flanged on the sides to make it more rigid. The tank is a 12¼ in. x 33 in. air reservoir, equipped at the front end with 1 in. pipe fittings, through which the air supply enters and the oil is passed to the burner. The tank is well sheathed, with sufficient air space to amply protect the reservoir from the heat of the furnace.

The furnace is built from 3/16 in. boiler or tank steel with all seams welded. The inside is thoroughly lined with fire brick and clay, which is easily replaced when necessary.



Details of Portable Furnace for Heating Rivets.

The New Overland Limited.—An extra fare train has been put in service between Chicago and San Francisco, running over the Chicago & North Western, Union Pacific and Southern Pacific. The run is made in 64 hours.

Steel Passenger Car Design

Papers Presented at the Railway Session of the American Society of Mechanical Engineers.

Thirteen papers, each on a different subject connected with the design of steel passenger train equipment, were presented at the Railway Session of the American Society of Mechanical Engineers, held in New York on the evening of April 8, 1913.

THE GENERAL PROBLEM.

The opening or introductory paper was presented by H. H. Vaughan, assistant to the vice-president, Canadian Pacific. After pointing out the difference in the conditions which control the development of the steel passenger car from those which influenced the design of the steel freight car at its inception, he stated that the questions that now confront us relate to the design and construction of cars of the present type and of the materials that may be advantageously employed in place of the wood which has been used for so long. They are complicated by the necessity of providing for greater safety for the passengers than was secured in the wooden car, with an equal degree of comfort, and the difficulty of anticipating the behavior of this new equipment in the case of accident. Certain difficulties, such as the best systems for heating, lighting and ventilation, are common to both steel and wood construction, and improvements in these matters pertain to general progress rather than the use of steel construction.

The steel underframe and wood superstructure does not appear to be a satisfactory or permanent development. There is but little saving either in weight or cost over the all-steel construction, and it is difficult to see how the same strength in case of accident can be obtained. It can hardly be regarded except as an intermediate step between all-wood and all-steel construction.

In all-steel construction the side-girder car presents advantages, but as in freight construction, both types will probably persist. The side-girder construction obtains greater strength on the side framing without superfluous weight, and it is possible that greater framing strength may prove necessary. With equal strength of side framing, the side-girder car may be made lighter than the center-girder type, and the weight of steel passenger cars is one of the most serious problems to be faced by any railroad not having a level line. Apparently side-girder cars as so far constructed have a decided advantage over the center-girder type in their light weight and greater strength in case of accident tending to crush in the side of the car. This will probably lead to the use of this type on roads on which weight is of importance.

The circular roof has been extensively introduced on steel passenger cars on account of its lightness and simplicity of construction. It has the objection that deck sash ventilation cannot be employed. The deck sash is of value for this purpose in a standing car and, when properly screened, is certainly advisable in hot weather, especially when the road is dusty. The Canadian Pacific has compromised on this question and is using a roof of approximately circular form with deck sash. The strength and simplicity of the circular roof is retained with the ventilating qualities of the clerestory type.

The preferable material for inside finish is a matter for future decision. With the ample protection afforded by a steel car against accident, there does not appear to be any objection to wood inside finish on the ground of safety. It is more ornamental than steel and a better insulator. There is today very little difference in cost, and it appears probable that in the future the tendency will be to adopt steel interior finish, if not entirely, at any rate to a great extent.

The floor construction in steel cars is entirely different from that in wooden cars, and is usually of metal covered with a flexible cement. In constructing a sample car, the writer used in addition an underfloor covered with insulating material, and covered the cement with ½ in. of cork. This car was also exceptionally well insulated at the sides, 2 in. of cork being used next to the outside plating. Tests during the past winter have shown that this car is actually warmer than the ordinary wooden car, the same amount of heating surface being used in both types. The question of insulation is an important one, both in hot and cold weather. With proper insulation there is no question of the steel passenger car being satisfactory.

PROBLEMS OF STEEL PASSENGER CAR DESIGN.

W. F. Kiesel, Jr., assistant mechanical engineer, Pennsylvania Railroad, outlined briefly some of the more important problems that confront the designer. Before the first steel passenger car for regular steam railroad service was built, a committee composed of representatives of both car builders and railways carefully analyzed the whole subject and reported that, at first, steel passenger cars would cost approximately 20 per cent. more per passenger than wooden cars of the same type, but that the steel cars would probably cost much less to maintain. This committee, however, was of the opinion that the probable decrease in cost of manufacturing steel cars and the increased cost of good lumber would soon absorb this differential, and Mr. Kiesel stated that at the present time steel passenger cars cost no more than equivalent wooden cars.

Differences of opinion still exist as to whether the cars shall be all-steel, or steel frame with wood lining. In the all-steel car the steel lining can be securely riveted to the framing and adds somewhat to the strength of the complete structure. Satisfactory results have been realized from the use of a double steel lining between the seats, forming a hot-air duct, extending from the heater pipes to the window sill, with an outlet through small holes in the lining proper, located immediately below the window sill. Wood lining requires considerable wood furring, and adds weight to the car without adding to the strength. As a car with metal lining riveted to the framing has the advantage in strength, weight and cost, it will gain in favor. The results of several years' experience indicate that the lining must be insulated throughout and, if the spaces between lining and sheathing are properly isolated, little is gained by insulating the sheathing; more will be gained by the use of double windows. Furthermore, the heat lost in cold weather by conduction through and radiation from the walls, in cars with insulation on the lining alone, is negligible when compared with the heat carried off by adequate ventilation.

The laws governing load-carrying strength are well known, but this cannot be said of the laws governing wrecks. Each wreck forms a separate study, and we seldom find two that can be placed in the same class. The study of wrecks shows that the car underframe must be reasonably strong to resist end strains, that the ends of the superstructure must be reinforced with strong vertical members, and that the car must not collapse when rolled down an embankment.

A better knowledge of the relative value of steel and wood in car construction has led the designer to abandon the basis of ultimate strength of the material, and to substitute the

basis of elastic limit, and finally to select a ratio of 4 to 1 as the relation of the elastic limit of steel as used in cars, to that of good timber.

Selecting from the last generation of wooden cars one used in heavy trunk line service, with four 5-in. x 9-in. wooden sills bunched together near the center, and so located as to be nearly uniformly affected by the end strains, steel platforms with draft gear securely attached, and the remainder of the car to correspond, the analysis of its end-shock resisting capacity leads to the consideration of the elasticity of the material, the transverse bracing preventing buckling, the concentration of strength near the longitudinal center line of car, and the reinforcement at the platforms. A corresponding steel car should have a center sill area of 45 sq. in. braced against buckling, a strong and efficient draft gear as a substitute for the elasticity of the wood, and a ratio of 0.04 for stress to end force, the calculations to include consideration of the lever arm of force below the neutral axis of the center sills. For lighter service a steel car with a center sill area of 32 sq. in. and a ratio of 0.05 for stress to end force may be considered as a substitute for a wooden car with four 4-in. x 8-in. sills bunched near the center of the car. The use of steel permits a distribution of material to better advantage than is possible with wood. The box girder center construction is continually gaining in popularity, the strong vertical members at the car ends, to prevent one car overriding and penetrating the superstructure of another, are now considered a necessity, and a superstructure, including a roof sufficiently strong to bear the car when turned upside down without collapsing, is very desirable.

The impression that cars with six-wheel trucks necessarily have better riding qualities than those with four-wheel trucks has proved to be incorrect. The substitution of four-wheel trucks for six-wheel trucks saves about 18,000 lbs. per car. Increased journal bearing surface obtained by an increase of diameter of journal only is of little or no benefit in preventing hot boxes, because the periphery velocity increases in the ratio of the diameters. The weight per journal should not exceed 1,500 lbs. per inch of length. A long spring base, low-lying center plate, and anchoring the dead levers to the car body instead of to the truck frame promote smooth action and easy riding at all times. The equalizing springs should, therefore, be placed as near to the journal boxes as possible, or directly over the boxes, and the bolster springs should be on or near the center line of the truck sides. If the dead levers of the truck brake are anchored to the car body, the truck frames have no tendency to tip when the brakes are applied, and the jarring effect is entirely eliminated. A special axle with 5½ in. x 11 in. journals for passenger cars would be of material benefit and would permit using four-wheel trucks under all coaches and 60-ft. baggage cars. Longer cars with six-wheel trucks would have sufficient margin for the excessive loads sometimes encountered and the danger of hot boxes would be avoided.

ROOF STRUCTURE.

C. A. Seley, mechanical engineer of the Rock Island Lines, presented the discussion on this subject. His paper, in part, is given below.

The advent of the steel car has encouraged the use of the oval roof, particularly for cars used for baggage, express, and postal purposes. It is cheaper to build and maintain and fulfills requirements for such cars. For passenger cars the clere-story type prevails very generally, as it assists in lighting and ventilation and in decorative effect.

The framing for oval roofs consists of carlines, each a single member, bent to the shape of the arch and extending from plate to plate. There are no through longitudinal members and the roof sheets are riveted to the carlines.

The shape of the carlines of either type of roof should be such as to facilitate fastening of the roof and of the inner ceiling or finish, and between these there should be a generous amount of insulating material to intercept the heat of summer and the cold of winter.

The specification for full postal car construction, approved by the Postoffice Department in March, 1912, contains the following paragraphs in regard to the roofs of such cars and is probably as authoritative a statement as there is available. The strength of roofs of some cars that have been rolled over in accidents has been checked against the formula used, and has been found ample to afford support against serious roof distortion in such cases.

"The roof may be of either the clere-story or turtle-back type. In the clere-story type, the deck plates shall be in the form of a continuous plate girder, extending from the upper-deck eaves to the deck sill, and either built up of pressed or rolled shapes or pressed in one piece from steel plates. The carlines may be either rolled or pressed steel shapes, extending in one length across the car from side plate to side plate, or may extend only across the upper deck. In the latter case the lower deck carlines may be formed by cantilever extensions of the side posts or by independent members of pressed or rolled shapes. In the turtle-back type, the carlines may be of either pressed or rolled shapes, extending in one length across the car between side plate and side plate, or may consist of cantilever extensions of the posts.

"The projected area of the portion of roof in square feet, supported by carlines, divided by the sum of the section moduli of the carlines, must not be more than 100.

"Roof sheets, if of steel or iron, shall be of a minimum thickness of 0.05 in., and either riveted or welded at their edges."

SUSPENSION OF STEEL CARS.

E. W. Summers, president of the Summers Steel Car Company, Pittsburgh, Pa., drew attention to the fact that the unevenness of the track due to natural causes as well as the necessary change in the rail level on curves, made the proper suspension of steel car bodies a difficult problem. He stated that in passing from a tangent to a curve the truck on one end of the car might be in wind with that on the other end by as much as four or five inches, depending on the degree of curvature and the length of the car. This statement was later questioned by Mr. Pilcher, who stated that an examination of a car with fifty-foot truck centers, and on the sharpest practical curve showed that the difference in level of the two trucks would not be over one inch. Mr. Summers did not have an opportunity to reply.

An abstract of Mr. Summers' paper follows:

Steel car bodies of the enclosed type, such as box, mail, baggage, or passenger cars, are of rigid construction and have high torsional resistance. The use of truck springs helps the illusion that we are distributing the car body load on all of the wheels. The uneven deflection of the springs indicates directly the increased load of one spring over the other. When the track surface is warped more than the total spring travel, the whole load is carried at two diagonal corners, tending to twist the car body. This twisting tendency is constantly changing, first in one direction and then in the other, as the super-elevated rail changes from one side of the track to the other.

The necessity for flexibility between the car body and the trucks, and for an even distribution of the load on all of the wheels seems not to be fully appreciated as yet, but with each succeeding year wrecks due to broken rails, wheels and truck structure, will drive this home. Suspension of steel cars, as has been developed by the writer in the past three years, does permit of a more even distribution of the load upon the wheels than with center-bearing trucks. (Mr. Summers' method of side suspension was fully illustrated and described in the *American Engineer*, April, 1912, page 194.)

With this type of suspension, the car body is carried at each side almost directly under its rigid side girders, which have great depth and can carry the load with the least deflection. Floor beams may be made continuous from side to side of the car. The necessary buffing and pulling column may be dis-

posed with its web in a horizontal position under the transverse beams, greatly simplifying the car framing.

SIX-WHEEL TRUCKS.

John A. Pilcher, mechanical engineer of the Norfolk & Western, after discussing the various parts of a passenger truck separately, summed up the subject as follows: The introduction of heavy passenger equipment is rapidly doing away with both the four-wheel and six-wheel wooden frame trucks. Cast-steel one-piece frames, and riveted wrought-steel frames of various cross-sections have been worked out and are now in use; both are reported as giving satisfactory service.

The cast-steel one-piece frame has become a great favorite even in the face of the high unit cost of these particular castings. The adaptability of the castings to the various changes of form and section necessary on account of the limited available space has no doubt had much influence. The attractiveness of the one-piece structure, eliminating all joints, and furnishing a frame ready set up, is another strong argument in its favor. The manufacturers having control of this cast-steel truck frame have evidently been successful in reducing to a minimum the concealed flaws often met with in steel castings. This, no doubt, has added largely to its popularity.

While the absence of riveted joints and the consequent doubling of material at the joints, helps to keep down the weight, the fact that the working fiber stress of cast steel is taken low, and the sections at many points have to be made larger than is necessary, on account of foundry limitations, the weight of the frame as a whole is great. This added to the large unit cost for special steel castings makes the user pay well for the advantages gained.

The riveted wrought-steel frame seems to have been held back in its development by the success of its rival in cast steel. Many users have shown conservatism in making use of the good thing already considered acceptable, hesitating to try out the different construction with the hope of lower first cost, with less weight and equally good service. Wrought steel at a very moderate unit cost has the advantage of a very reliable material which can be worked to a relatively high fiber stress. The cost of fabrication, when the work is done in any large quantity, added to the cost of material, will still leave a large margin in its favor. Is it possible that the lack of a specially interested advocate has prevented its virtue from becoming prominent, and delayed the experience needed to prove its worth in actual service?

I find several railroads building and using both four and six-wheel trucks, of the usual type of construction, with riveted wrought-steel frames, and from all reports they are giving satisfaction. One railroad is using both four and six-wheel trucks, of a form of construction differing from the ordinary type, but built of riveted wrought steel. As a large number of these are in daily use and they are constantly being built, they must be proving the worth of the riveted wrought-steel construction, as well as that of the special type of construction.

Several years' experience and a careful comparison of the cost of maintenance will be needed to determine whether the one-piece cast-steel frame, or the riveted wrought-steel frame truck would be the most advantageous, when both the first cost and weight are considered, together with the cost of maintenance.

Variety of choice offers an opportunity for discussion. In the hope of bringing out this discussion we advocate for steel passenger cars: Six-wheel trucks; the riveted wrought-steel frame; the use of the M. C. B. standard axles, boxes and parts, and pedestals, and 36-in. wrought-steel wheels.

STEEL INTERIOR FINISH.

Felix Koch, assistant mechanical engineer of the Pressed Steel Car Company, stated that there has always been, and still is, a difference of opinion as to how far it is advisable to substitute metal for wood in passenger car construction. He did not object to the use of a small amount of wood in the interior finish as, for instance, window sash, moldings, seat arm rests, window capping, etc., as it has certain advantages over steel which are desirable. Wood, however, should be eliminated wherever possible on account of the many advantages possessed by steel, among which may be mentioned: Non-combustible; prevents splintering in case of wrecks; easily removed should it become necessary to repaint the car on the inside surface of steel sheets; makes it possible to increase the interior width of the car where the outside width is limited; avoids trouble which may be experienced due to the different expansion of the materials, steel and wood; and it will, by comparison, be cheaper every year for the reason that it becomes more difficult to obtain the right kind of lumber for interior finish. The three to four years' apprenticeship required to become an expert able to apply wood finish to a car is reduced to six to twelve months with steel. A more uniform color can be maintained on steel finish than on wood, and the average life of paint applied to steel finish will be much greater for the reason that wood darkens with age. It is possible to manufacture the interior finish in much less time by the use of more men than it is possible to employ when applying a wood finish, as only a limited number have room to work at the same time in a car when the greater part of the fitting and cutting, etc., has to be done.

All of these advantages are almost exclusively confined to the use of steel or other metals, although a composite material of a wood pulp nature or similar material made fireproof and waterproof by different processes, if applied in a proper way and used for ceilings and below the window sills, is not objectionable, and may be applied in practically the same manner as stated.

The advantages possessed by wood over metal as a non-conductor can be very much reduced by the use of proper insulating material correctly applied.

PAINTING STEEL PASSENGER CARS.

C. D. Young, engineer of tests of the Pennsylvania, presented one of the most interesting papers of the evening. He described at some length the method now being used at Altoona, of artificially drying the paint on steel car bodies and trucks by means of an oven. An extensive abstract of Mr. Young's paper will be found in the Shop Practice section of this issue.

ELECTRIC LIGHTING.

H. A. Currie, assistant electrical engineer of the New York Central & Hudson River, presented a brief paper in which he drew attention to some of the features to which the designer should give careful attention in order to improve the reliability of the electric lighting of cars. He said in part:

From a standpoint of practical consideration for the welfare of passengers, the lighting plays one of the most important parts; therefore, every effort should be made to arrange the light units so that no discomfort is occasioned, and to install the apparatus and wiring so that operating failures are reduced to a minimum.

Convenience and accessibility of apparatus, fixtures, junction boxes and wiring mean much to the inspector. The average inspector will pay little attention to those parts which are difficult of access, and much better inspection work will result where parts are arranged in a get-at-able manner. It is of equal importance that the various parts be protected in such a way as to avoid all possibility of injury to them while the car is in service. The other essential features of the lighting installation are discussed in the following paragraphs:

It would be a consummation much to be desired if truck designers would provide a generator support built integral with the truck. The requirements are not difficult and it is certain that the generator builders would be glad to make their machines conform to the truck builder's suspension. For mounting the axle pulley, a straight machined seat should be provided in all cases if electric lighting is planned or can be anticipated.

Head room for the generator should be considered in laying out deep center girders, brake rigging and piping. All the open space that can be provided about the generator is desirable because it facilitates thorough inspection. The generator terminal board should be attached to the underframe of the car close to the generator and readily accessible.

The switchboard locker should be so located as to be at all times easily accessible to the trainmen; no pains should be spared in the design and installation of the board; nothing but fireproof material should be used. A receptacle for spare lamps and a report card holder are convenient accessories. The regulator locker is generally located under the switchboard and on the generator end of the car. Good ventilation is a necessity. Provision against dampness and dirt is imperative. The regulator lockers should be fitted with locks.

It was formerly customary in applying electric light to retain gas lighting as a reserve. Increasing reliability of electric lighting apparatus has made this unnecessary and in the best present practice no gas equipment is provided. For emergencies it is customary to provide holders for candle lamps but it is only on rare occasions that these have to be used, if the electric equipment is of a good modern type.

ELECTRICAL EQUIPMENT ON MOTOR CARS.

F. W. Butt, assistant engineer in the electrical department of the New York Central & Hudson River, stated that particular attention should be given to locking bolts, nuts, screws, etc., to prevent them working loose on account of vibration, especially those which are used to secure the electrical apparatus. The vibrations of the motor gearing are transmitted to all parts of the car and they are more pronounced when the motor suspension lug is mounted on the truck transom, without the use of suspension springs. Vibration is more easily transmitted through the solid structure of steel cars than it is in cars of wood.

In the design of new cars it is sometimes found convenient to locate various members of the structure, especially in the underframe, so that the apparatus can be suspended from them without the use of intermediate supports. This is desirable, as it is often found that many extra parts may be omitted from the car. Where heavy apparatus is to be suspended from intermediate supports, large heavy members are required, necessarily complicated in design in order to obtain clearance between parts of the structure or apparatus.

Where it is possible, hangers should rest on the members which support them and not depend entirely on a vertically bolted or riveted connection. The hangers should be well braced, especially those which hang far below the underframe, to prevent swaying of the apparatus, due to the motion of the car. The hangers can be so designed as to provide the necessary bracing.

It is recommended, in order to interfere as little as possible with the general anti-telescoping scheme, that two small switchboards be used, one placed in the bulkhead on each side of the body-end door opening, and located as high above the platform as the size of the boards will permit.

AIR BRAKES FOR STEEL PASSENGER CARS.

A. L. Humphrey, vice-president and general manager of the Westinghouse Air Brake Company, briefly reviewed the development of the air brake, made necessary by the continual increase in the weight of high-speed passenger trains. The perfection of the electro-pneumatic brake and the clasp brake were mentioned as the latest developments in this field. It was shown that the weight on drivers of high-speed passenger engines had increased from 25,000 lbs. to 180,000 lbs. since the introduction of the air brake, while the drawbar pull has increased from 7,000 lbs. to 30,000 lbs. The weight of passenger cars has increased from 20,000 lbs. to 150,000 lbs. while, at the same time, schedule speeds of passenger trains have increased from 30 miles an hour to 65 miles an hour. Taking the average weights of trains and average speed at the time the air brake was introduced as compared with the trains and speeds of today, the weight per vehicle has not only increased nearly eight times, but the foot-pounds of energy to be destroyed is nearly 15 times as much. In order to meet the demands of modern service conditions as efficiently as heretofore, means should be provided for dissipating the total energy stored up in this swiftly moving mass in at least as short a time and distance as before. In fact, it is desirable to do this in as much less time as is consistent with comfort to passengers and accuracy of control, in the case of service stops, and in as much shorter distance or time as may be possible in the case of emergency. Not only must the brake be automatic in its operation, but it must be capable at any time and under any conceivable circumstances of producing the maximum possible retarding force within as short a period of time as the known resources available and physical limitations will permit.

When we consider that it requires a distance of 8 to 12 miles for a locomotive of modern design, hauling a train of say ten cars, to accelerate to a speed of 80 miles an hour and that this same train should be brought to a standstill within the shortest possible time, say in one-tenth of the distance required to accelerate to this speed, it is hardly conceivable that this can be done with the means available, which is a retarding force produced by frictional contact of metal shoes against the wheels, which is, in turn, limited by the adhesion between the wheels and the rail.

The improvements made in air brakes in recent years, which have made it possible to control the present heavy high-speed passenger trains with approximately the same degree of efficiency as the older forms controlled the equipment of their day, have been based on scientific principles and experience in obtaining reliable information and data. The matter of time of transmission of compressed air was not so important a factor with the shorter trains and slower speeds as it is today, where a train running at 80 miles an hour passes over a distance of 117 ft. a second; consequently a few seconds saving in the time of getting the brakes fully applied is just so much relative gain in the time and length of stop. With the latest improved pneumatic equipment, the maximum brake cylinder pressure can be obtained throughout a modern train of ten cars in 4 seconds, which is the shortest possible time that this can be obtained by serial quick action through a train of this length. For the purpose of shortening this time serious consideration is being given by some railroad officers to the type of brake equipment used on the New York subway, and known as the electro-pneumatic, which would not only tend to cut the time of full application in two, but by means of the electric control all brakes are applied simultaneously, which not only assists in shortening the stop but in preventing shocks, etc.

Another equally important factor now coming more prominently in use is the application of brake shoes to each side of the wheel, known as clasp brakes. The virtue of clasp brakes, however, is not so much in the aid they afford in shortening the stop as in the equalizing effects of pressure on the wheels, journal box bearings and trucks, the minimizing of lost motion which affects the brakes through increased piston travel, and the less tendency toward wheel sliding while the brakes are applied.

CAST-STEEL DOUBLE BODY BOLSTERS.

C. T. Westlake, chief mechanical engineer of the Commonwealth Steel Company, briefly reviewed the history of cast-steel as a reliable material for steel passenger car underframes. This material was comparatively unknown as recently as 1893, but since that date has been used in an increasingly large number of places throughout the car.

Mr. Westlake stated that the ideal underframe should have all connecting members in the same plane so as to avoid buckling due to eccentric loading; it should be so designed that each member will independently perform its individual functions,

passing the stresses from one member to the other through the smallest number of properly alined connections; and all should be so arranged in relation to each other as to form one powerful, compact, shock-absorbing element throughout the length of the car.

This can be accomplished to advantage in cast-steel construction since the metal can be properly distributed in proportion to the stresses. The gusset plates can be placed in the same plane as the flanges of intersecting members, and the whole reduced to minimum weight and to the smallest number of parts with practically no joints. It can be molded to any desired conformation, can be shaped to any curve, useful or ornate, without the use of expensive dies, and can be provided with necessary projections joined to the main members by proper fillets. Openings may be provided with finished and reinforced edges, and all parts may be molded to symmetrical, pleasing contour, all edges rounded and a complete, practical, operative device, emanating from a single source, furnished to the car builders ready for application.

The underframe receives the force of end collision as a column load on its longitudinal members, while the end frame receives it as a transverse load on exposed members supported at their ends. As it is impracticable under these conditions to make the end frame equally as strong as the underframe, provision should be made for protecting the end frame against destructive forces. The underframe should be arranged so as to receive the initial impact, and if the encountered force is sufficient to destroy it, it should fail in such manner as to form additional protection to the end frame.

This is accomplished in cast-steel construction by arranging the parts of the longitudinal members so that when loaded to destruction by a collision force, the end portions yield upwardly, thus folding the exposed portion of the platform up against the end of the car body, and forming an addition to the end frame to assist in distributing the force to all the longitudinal members of the superstructure. The advantage of this construction has been demonstrated in wrecks when this identical action has taken place, the safety of passengers being assured, and the property loss low.

In designing the cast-steel end frame we assume it to be a beam supported at its upper and lower ends and loaded at a point about 18 in. above its lower end. We provide connections between the end frame and balance of the car frame of sufficient value to develop the full transverse strength of the end frame; the vertical members of the end frame are connected by horizontal members so that in case the end frame is loaded to destruction the connections are sufficient to disrupt all the longitudinal members of the car frame, and when they yield, all parts will be forced toward the center of the end of the car and tend to prevent one car telescoping the other.

Cast steel stands preëminent in car construction as the best material for reducing the weight and number of parts to a minimum while maintaining requisite strength and other essential properties, and its popularity and use will proportionately increase as its benefits and advantages become more generally recognized.

UNDERFRAMES.

John McE. Ames, mechanical engineer of the American Car & Foundry Company, confined his remarks to the underframes of steel passenger cars for through service, or those at least 70 ft. in length, and did not attempt to discuss underframes for suburban or individual service where they are not subjected to the same severe service strains. Lantern slides were used to demonstrate the effect of severe collision shocks on the center sills and other parts of the underframe of the various types mentioned in the paper. These showed that the designs recommended by the author were fully capable of withstanding the most severe stresses that could be imposed on a passenger car.

Abstracts from the paper prepared by Mr. Ames follow:

The natural division of underframe designs is: The load carried equally on all of the sills; the load carried on the center sills only; the load carried on the sides only; the load carried on both side and center sills.

Each of these types has its partisans and each is in successful operation today. The first is used abroad almost universally and at home for repairs under wooden cars, the bodies of which are too good to destroy but need better underframing. With most of the foreign cars the body rests on and is bolted to the underframe from which it may readily be removed. The buffing and draft conditions differ from ours in that the buff is taken through the side sills on account of the use of separate side buffers, and the draft through the center sills. This permits of a distribution of metal in each sill member to give a uniform stress.

An example of the first type designed for a wooden superstructure, consists of four deep sills of what is known as the fish-belly type. These center sills are composed of vertical 5/16-in. plates, 30 in. deep at the center with 3 in. by 3 in. by 3/8 in. angles riveted along the top and bottom edges; the plates are reduced to a depth of 12¾ in. over the bolster. The center sills have a square inch section of 37 at the center and 26 at the draw gear. One disadvantage in these long plate sills is that when punching the line of holes along the edges the plate becomes distorted and wavy. It is then difficult to rivet the angles in place and obtain their full value. Again, in case of accident and the dropping of the underframe on the roadway, the bottom angles are bent or broken, making a difficult repair operation.

In general, the deep side sill has been discarded because of the difficulty of inspection beneath the car. The deep center sill is much in vogue at present because it looks strong, but on a car with deep center sills inspection must be made of the parts attached to the underframe from one side of the car at a time, and the introduction of axle light equipment becomes difficult on account of the interference of the deep sills. Again, to sustain its own weight without deflection on a 60 ft. span, too much weight of metal is required to make such a sill economical.

Of the second type, that is, with the whole weight to be carried on the center sills, a common form has center sills of two special 18-in. channels with ½-in. cover plates top and bottom, all sections extending the full length of the car in one piece. The box girder so formed has a square inch section of 50, and the superstructure load is transferred to these sills by means of four cross bearers, two of which take the place of the body end sills in other designs. There are no side sills as such, the angles simply forming the attachment for the superstructure. The parts are usually assembled with the bottom of the sills upward and allowed to deflect. The girder is then reversed and the camber straightens out by the weight of the metal. The sills are the same depth and section throughout their length and with this construction a truck of special design must be used, the center plate of which must be nearer the rail than usual. The weight of the body rests on the side bearings as well as the center plate. The service given by this underframe has been excellent.

The third type, with all the weight carried by the car sides, has the center sills used only for buffing and pulling. An example which may be referred to has two I-beams running the full length of the car in one piece, with a square inch sectional area of 23. They are held up by the three cross bearers which pass under and are attached to them. There are no side sills, the carrying members being the sides of the car. These members are composed of ⅛-in. plates, about 36 in. deep, stiffened vertically by the window posts and having a 6 in. by 6 in. by ⅝ in. angle at the bottom and an equal square inch section of metal at the belt rail, the two girders having a square inch section of 48 in all. With this construction a substantial body bolster is essential, as the weight must be carried at the bolster extremities. Usually a cast-steel structure, built into the underframe

and securely riveted to it, is used, as the weight of the metal may thus be economically distributed. With an underframe of this type there is no trouble due to difficulty of inspection or interference with attachment for axle light or other equipment under the car.

The fourth type is a combination of the second and third. Here deep center sills are used, having a section of about 40 sq. in. at the center and 39 sq. in. in cast steel at the draw gear. The side girders have a combined section of 21 sq. in. Most underframes of this type now in service are built with cast-steel ends, and portions which include in one casting the body bolster, platform, side and center sills extending as far back of the bolster as may be necessary to secure a substantial connection to the center sills proper.

While several of these four types have been in service for a number of years, the required time has not passed in which to develop structural defects due to unseen causes, such as fatigue of metal, crystallization, etc. If such defects exist they should make themselves known during the next three or four years, if freight construction is any criterion. We know fairly well the behavior of these types under unusual service conditions due to wrecks.

SPECIAL ENDS FOR STEEL PASSENGER CARS.

H. M. Estabrook, president of the Barney & Smith Car Company, briefly traced the development of passenger car ends and roofs from the beginning. It was shown that until the advent of the narrow vestibule in 1887 no systematic attempts had been made to strengthen the ends of cars. The broad vestibule was introduced in 1888. About the year 1890 there came in use what was known as an anti-telescoping end framing. Somewhat later this type of end framing was elaborated on.

The increased weight of the vestibules and anti-telescoping end framing developed the necessity for a stronger platform construction than the old style wooden platform that had been used for many years. About the year 1895 the standard steel platform, composed of steel I-beams, came in general use, and was employed continuously until the advent of the steel car superseded it by other designs.

Notwithstanding the efforts of Congress toward the general adoption of steel passenger cars, it has been stated on reliable authority that no vestibuled wooden passenger car, in the construction of which was employed the anti-telescoping end framing, in a straight-on end to end collision (although frequently having the ends concaved) has ever had the end crushed in to the extent of the adjoining car body telescoping and entering it.

When the steel passenger car made its appearance about the year 1905, the passenger car entered a period of transition and evolution from which it has not yet entirely emerged with a recognized standard form of construction. In the construction of the early steel passenger cars an attempt was made to follow closely the lines employed in the construction of wooden cars, with the result that the first steel cars were inferior in strength of end construction to the prevailing wood construction, but the evolution has been rapid, one improvement following close on the heels of another. This has resulted in rapid improvement of end construction until we have today reached a design that is considered practically standard. This development has no doubt been hastened by the action of Congress relative to steel postal cars and the coöperation of committees of the railway mail service, the railroads and the car builders, to the end that a standard specification for the strength of the various parts of the car, and especially the end construction, has been adopted by the Postoffice Department.

There are at this time three distinct forms of construction employed: The one most generally used is composed of rolled-steel sections with the center sills running the full length of the car from buffer beam to buffer beam. Another type is that in which the rolled steel center sills connect at the bolster with a steel casting, forming a combined body bolster, center and side sills, and end sills. Another type is that in which the rolled-steel center sills connect at the bolster with a steel casting, forming a combined body bolster, center and side sills, end sill and the entire end frame of the car.

It is, of course, apparent that the weight of the steel car is much greater than a car of the same size of wooden construction, and that the wooden car possesses in itself a natural elasticity to absorb buffing shocks, such as are produced by collision, that the steel car does not furnish. Hence, in the development of the steel car, with the enormous increase in weight of trains and the high speed at which they run, there has been a growing tendency to increase the strength of the structure with the view of making it as nearly indestructible as possible to compensate for the absence of elasticity. It is also apparent that, notwithstanding the strength of the structure, if it encountered an opposing force of sufficient magnitude, it might be annihilated, and so this strengthening process, and the increasing weight and speed might go on indefinitely without furnishing the result sought for. It is equally true that if the structure is designed for such strength as to be indestructible, when the two opposing forces meet the movable objects within the cars, which is the human load, must suffer the damage. To avoid this possibility the idea has been evolved to construct that portion of the end of the car between the end of the main body and the vestibule face plates, so that it will collapse under a less shock than would be required to crush in the end of the car body itself.

This idea is based on the theory that in a train in which there are say ten vestibuled cars, there is the space between the main bodies of each two coupled cars occupied by the platforms and vestibules of approximately 8 ft., or in a ten-car train a space of approximately 80 ft., of shock absorbing space, which, if properly utilized in the instant of collision, would remove to a large degree the shock and resultant damage to the car body itself and likewise lessen the possibility of damage to the persons of the passengers. From this idea has developed what is termed a collapsible vestibule. It is generally conceded that if two vestibuled cars coupled together could maintain their respective horizontal planes at the instant of shock due to collision, there could be no telescoping and that telescoping is due to one car assuming, at the instant of collision, a higher or lower horizontal plane than its adjoining neighbor, causing one to ride the other with the resultant telescoping effects.

It is also generally conceded, that in cases of two cars tending to telescope, the point of maximum shock is never over 20 in. above the floor line. In the government postal car specifications, this point has been definitely fixed at 18 in. above the floor line, and with this in view the end posts are reinforced for a distance of about 4 ft. above the floor line by steel angles riveted to the Z-bar end posts.

In the construction of this collapsible vestibule the longitudinal sills and floor members are designed to stop at the end sill of the car body proper, the end of which is sheathed with a heavy steel plate extending in one piece vertically from the roof downward to the bottom of the end sill.* If the shock of collision is not entirely absorbed by the vestibule members before the end of the car body proper can be crushed, this plate will tend to pull the roof downward and cause the direction of the oncoming car to deflect obliquely upward. Further to offset the effect, should the two cars change their horizontal planes in collision, pressed steel shapes in the nature of anti-climbers, are placed below the buffer beam and platform.

The platform, vestibule and hood members are designed with a view of withstanding all shocks incident to regular service, but in abnormal shocks, such as would result from collision, the rivets connecting the various members would shear off with the exertion of less energy than would be required to crush the end of the car body, thereby causing the vestibule to collapse, absorbing the shock and furnishing a cushion between the two

*This design of vestibule and end was illustrated on page 87 of the February issue of the *American Engineer*.

car bodies proper. It is assumed that in case of a collision these would be the only parts seriously damaged, and the car could be repaired and replaced in service with a minimum of expense and delay.

The entire collapsible vestibule, comprising the platform, vestibule and hood, is constructed as a unit, detachable and separate from the car body proper and can be applied after the car is built or in the alteration of cars already built and is equally applicable to cars of either steel or wood construction.

MINE RESCUE CAR

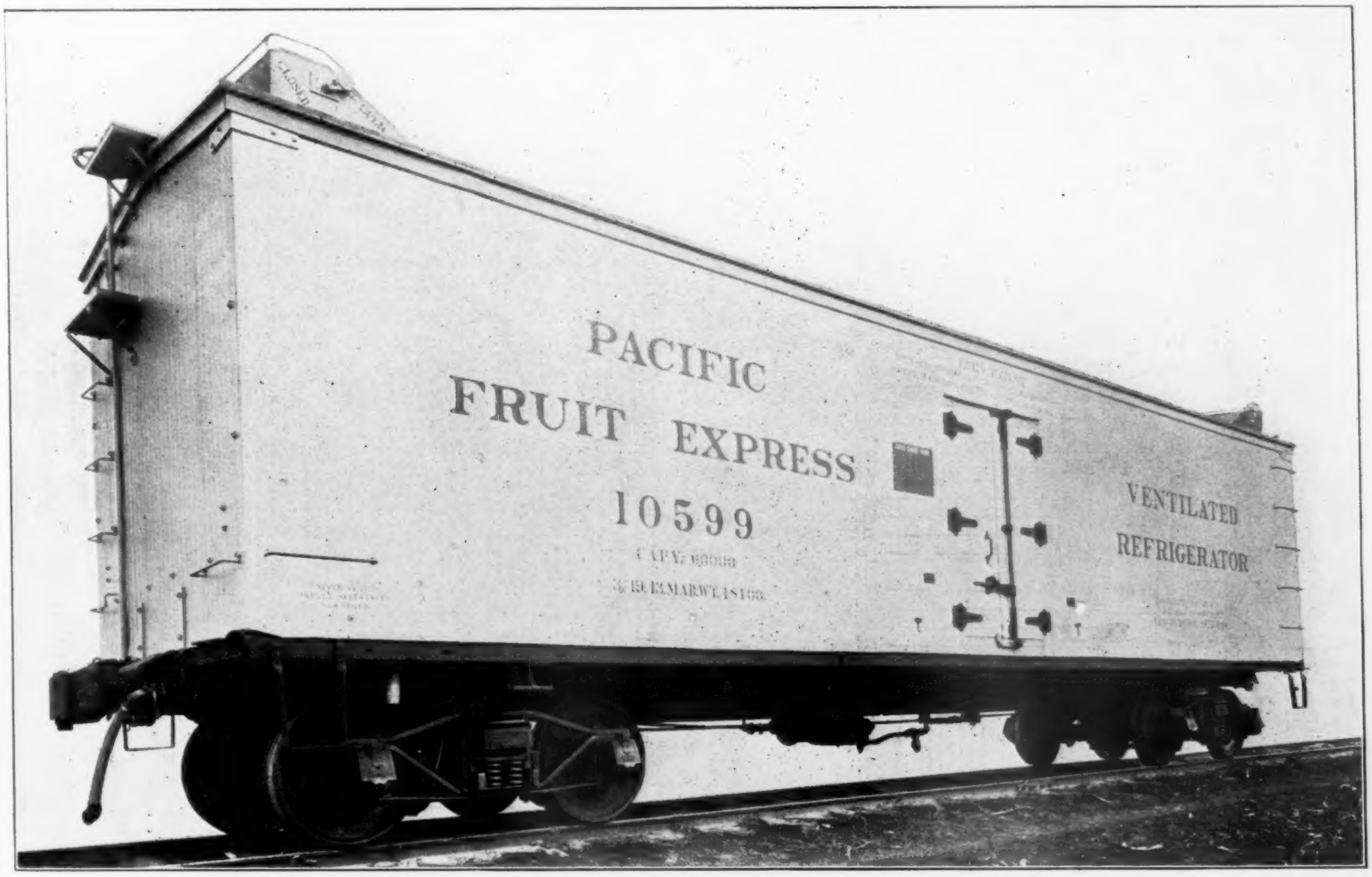
A special car has been built by the Lehigh Valley which contains apparatus and facilities for use in mine rescue work and in caring for the injured at serious mine disasters. It was formerly a combination baggage and smoking car; the baggage compartment has been fitted with an operating table, sets of surgical instruments, first aid supplies, and all other facilities of a first class operating room. There are six regular army stretchers held in racks overhead, and along the wall are fifteen large oxygen tanks and the pumps for charging oxygen helmets of which there are a dozen stored in this compartment. Other apparatus for rescue work includes the small oxygen tanks to be used with the helmets, spare potash cartridges, pulmotors, inhalers and tools for emergency mine work. In the former smoking compartment of the car a galley with a cook stove has been installed and there are two facing seats arranged so that they may be quickly converted into a bed. An overhead tank provides a liberal supply of water and both hot and cold water are at all times available. The car is heated by steam and is arranged so that the steam hose may be run to it from any colliery; there is sufficient radiation capacity to insure comfort in any weather. This car can accommodate fifteen men, and while primarily designed for rescue work is also being used for a demonstration room for instructing miners on the subjects of safety and rescue work.

REFRIGERATOR CARS FOR THE UNION PACIFIC

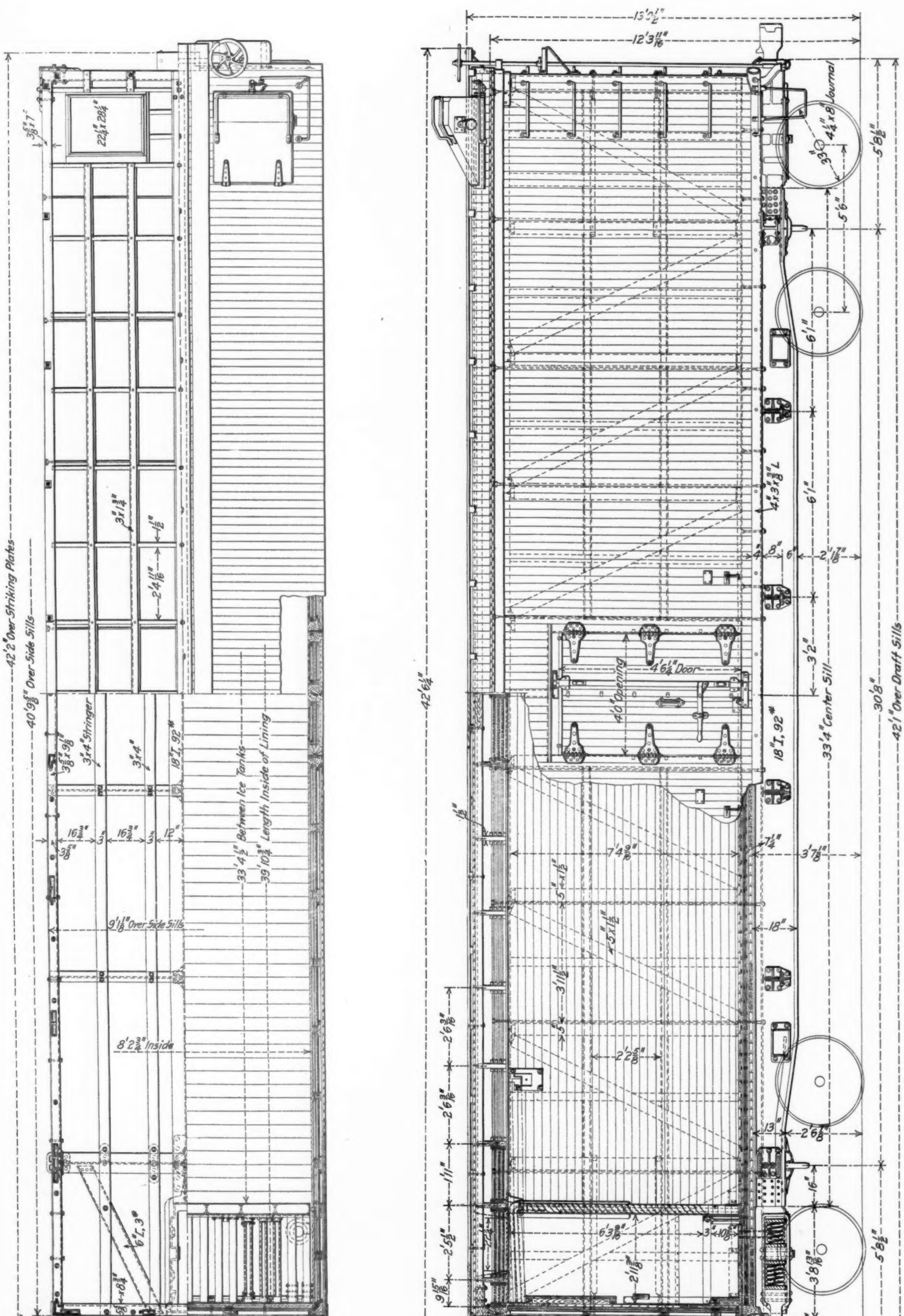
The Union Pacific has recently received from the American Car & Foundry Company a number of refrigerator cars equipped with Bettendorf steel underframes and the Bohn system of refrigeration. These cars, which are for the Pacific Fruit Express line, have a capacity of 60,000 lbs., are 39 ft. 10¾ in. long inside of the end linings, and weigh 48,100 lbs.

The center sill is an 18-in. 92-lb. I-beam, and is 33 ft. 4 in. long; the draft sills are of cast steel, with lugs cast integral for the draft springs, and are riveted to the center sill. The body bolsters consist of 8-in. 34.6-lb. I-beams; there are four cross-bearers, between the body bolsters, built up of 8-in. 18-lb. I-beams. The side sills are 4 in. by 3 in. by ⅜ in. angles and the end sills are 4 in. by 4 in. by ⅜ in. angles. The sub-side sills and sub-end sills are of Oregon fir, the former being 3⅝ in. by 9⅛ in., while the latter are 5⅝ in. by 8¾ in. Four intermediate stringers or nailing sills of 3 in. by 4 in. Oregon fir are used. The steel underframe is diagonally braced at the ends between the end sill and body bolster by two 6-in. 3-lb. channels.

Cement-coated nails are used throughout the car in the insulation. The first or blind floor is covered with a coat of hot Hydrex compound; the two intermediate floors are of ship-lapped Oregon fir, while the top floor is in two layers, both being tongued and grooved. Between the two top floor layers is a layer of Monarch mica surfaced car roofing insulation paper. The body framing is of Oregon fir throughout. Per Bona insulating paper, manufactured by the Lehon Company, is used in the sides, ends, doors and roof. In the insulation of the roof there are a ¾-in. inside lining, two courses of intermediate lin-



Refrigerator Car with Bettendorf Steel Underframe.

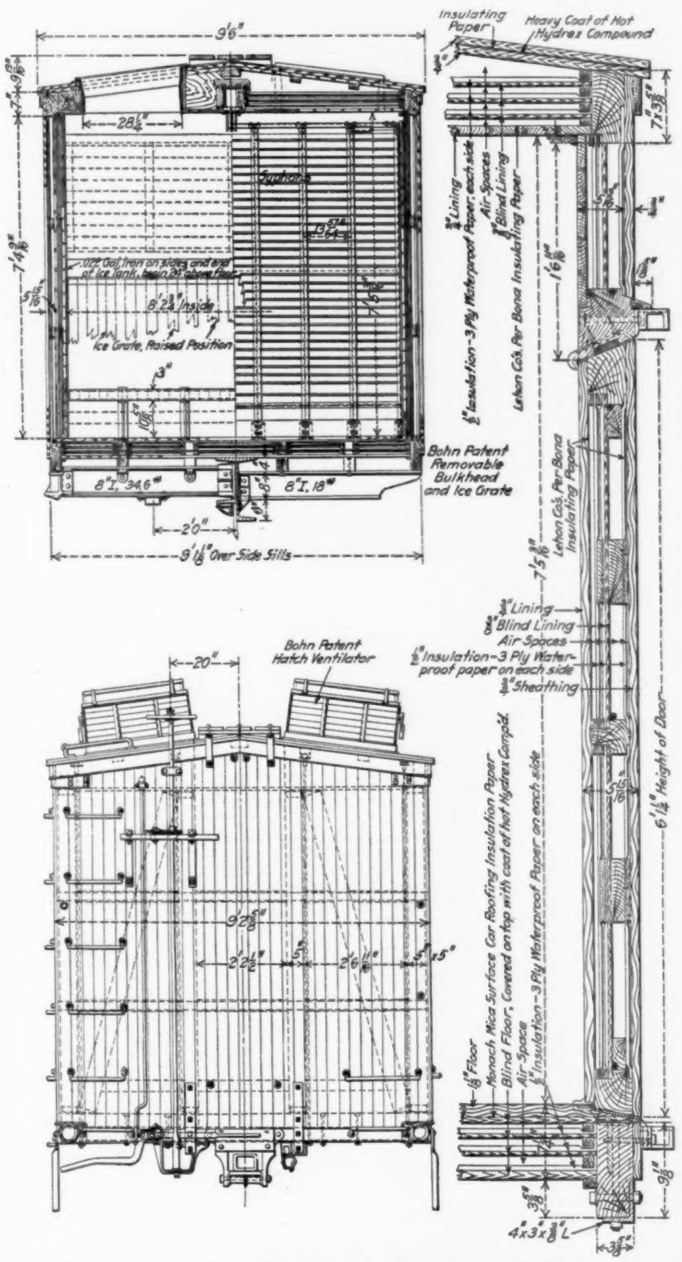


General Arrangement of the Union Pacific Steel Underframe Refrigerator Car.

ing and a ⅜-in. blind lining, all with air spaces between them, and there is also an air space between the blind lining and the roof proper. Between the two ¾-in. layers of roof boards is a layer of insulating paper and one of Hydrex compound applied hot.

There are four ventilators, one over each hatch, the latter having an opening 28¼ in. by 22¼ in., and there are four well traps, one located near each corner of the car. The hatches are equipped with the Bohn patent hatch ventilator, and are also provided with hatch plug indicators, which show whether the plugs are opened or closed.

The trucks are of the arch bar type, with 4¼ in. by 8 in. jour-



End Elevation and Cross Sections of Union Pacific Refrigerator Car.

nals, and are equipped with the Barber truck roller device. Chilled cast-iron wheels are used and the truck wheel base is 5 ft. 6 in. The side bearings are of the Miner gravity roller type; the draft gear is the Miner tandem, with M. C. B. class G springs.

The principal dimensions and data are given in the following table:

Length over end sills	40 ft. 9⅝ in.
Length over sheathing	40 ft. 11⅛ in.
Length inside of lining	39 ft. 10¾ in.
Length between ice tanks	33 ft. 4½ in.
Height, top of floor to ceiling	7 ft. 5 3/16 in.
Total cubic capacity	2,440 cu. ft.
Available cubic capacity between ice tanks	2,041 cu. ft.
Capacity of both ice tanks	11,000 lbs.
Width inside of lining	8 ft. 2¾ in.
Width over side sills	9 ft. 1⅛ in.
Width over sheathing	9 ft. 2⅝ in.
Width over eaves	9 ft. 6 in.
Distance, center to center of body bolsters	0 ft. 8 in.
Truck wheel base	5 ft. 6 in.
Total wheel base	36 ft. 2 in.
Height of side door opening	5 ft. 9⅞ in.
Width of side door opening	4 ft. 0 in.
Height, top of rail to eaves	12 ft. 3 11/16 in.
Height, top of rail to top of brake shaft	13 ft. 7¼ in.
Height, top of rail to top of running board	13 ft. 0½ in.
Light weight of each truck, about	6,100 lbs.
Weight of car complete	48 100 lbs.

CARE AND MAINTENANCE OF AIR BRAKES*

BY RALPH WOLFE.

On account of the increased size and efficiency of the locomotives throughout the country, which has resulted in the handling of 80 and 125-car trains, it has been necessary to make a more severe inspection of the air brake apparatus in order that the proper results may be obtained, which is not only the question of stopping the trains, but the results obtained at the time the stop is being made. The capacity of the cars has also increased, which has resulted in a larger volume of air to be handled and carried on each car to get the required braking power. This, of course, has resulted in the increasing of the pump capacity on the locomotive from 66 cu. ft. of free air to be handled per minute to 131, or about 100 per cent. With the increased pump capacity and the increased volume of air, there are many factors to be taken into consideration in order to get the proper operation of the brakes. There are (1) the efficiency of the pump and what it costs to pump against leakage on big trains; (2) the brake pipe leakage and if the rate of reduction is sufficient to cause undesired quick action of the triples; (3) the length of piston travel in order to get the proper brake pressure with a given brake pipe reduction, which will have the proper retarding effect on each car, and (4) the results obtained due to unequal distribution of braking power throughout the train.

With an 80-car train of 10-in. equipment, we have a volume of 275,200 cu. in. If the conditions were such that we had a 12-lb. brake pipe leakage per minute, we would lose 130 cu. ft. of free air per minute, which would be equivalent to the capacity of the 8½-in. cross compound pump. If the leakage was 6 lbs. per minute, we would be losing 65.5 cu. ft. of free air per minute, which would be equivalent to the capacity of the 11-in single stage pump. It is estimated that the 11-in. pump requires a coal consumption of 200 lbs. per hour; this would require 4,800 lbs. of coal to operate the pump for twenty-four hours. Estimating the price of coal at $2 per ton, it would cost $9.60 to pump against a 6-lb. leakage on an 80-car train for 24 hours. If 30 trains were being handled under the same conditions for 24 hours, it would cost $288 for fuel alone. While working under the same conditions with the 8½-in. cross compound pump, the cost of fuel would be approximately $100 for pumping against leakage.

With the cost of pumping against leakage, the question of handling the train without damage to the equipment has got to be considered, and what will take place when an automatic brake application is made. If with a 12-lb. brake pipe leakage per minute on an 80-car train, we lose 130 cu. ft. of free air per minute, when an automatic brake application is made, the rate of reduction will be increased 76 cu. ft. of free air per minute, making a total of 206 cu. ft. of free air per minute, which will cause all triples to move to full service position. If we have a valve in the train that is sticky or has a port restriction, an undesired quick action will be obtained which in many cases may result in the ends of two or three cars and as many draw-

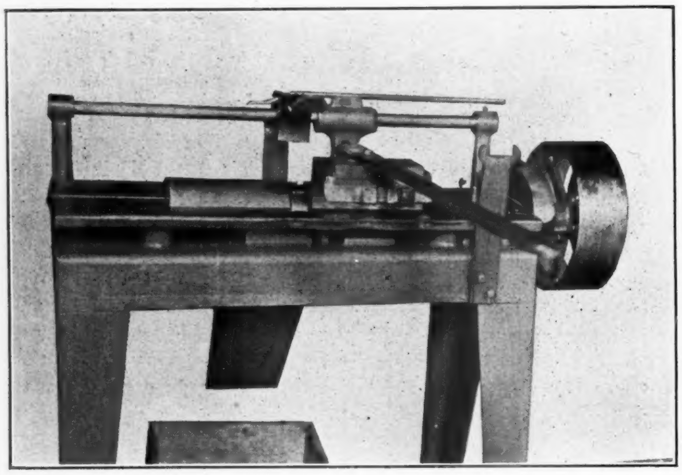
*Presented before the Car Foremen's Association of Chicago, April 14, 1913.

bars being pulled out. It is readily seen that under the above conditions the engineer has no control of the brakes in the way of a given brake pipe reduction. There has, however, been a decided improvement in the air brakes in the past two years. This has been due to the close attention given the triples, as well as the tests they are subjected to on the improved test racks.

But the conditions relative to leakage remain about the same; this is because the test given the cars at the time of cleaning is not severe enough to develop the small leaks, as it is customary when a car is cleaned to attach a hose to the brake pipe and test for piston travel and such leaks as can be observed by sound. If the cars were tested by coupling a dummy to the opposite end of the car from where the test hose was applied and the joints and angle cocks were coated with soap suds, it would indicate the small leaks, which are the ones that cause the trouble. This would show about 60 per cent. of the angle cock plugs to be leaking on account of foreign matter collecting on the plug, holding it from its seat, and that 50 per cent. of the hose couplings are leaky on account of improper application of the gaskets, which are the principal leaks that cause the trouble. This might require more help and more material; but, figuring the cost of pumping against leakage and the cost of maintenance of the equipment, a soap-suds test for all cars when on repair tracks will be economical.

CAR BRASS BORING MACHINE

Many car brasses are returned to the shop for rebabbitting, before they have covered their possible mileage, for some minor defect which might be corrected by simply boring them to a smooth bearing. In many cases, however, the time and labor incident to this work would not be warranted with the present equipment in most shops. The machine shown in the illustrations has been designed for this special purpose, and will handle brasses at the rate of five per minute. With such a machine located at the various division shops on a railroad system the brasses with minor defects may easily be bored and kept in service for a much longer time. This would materially reduce

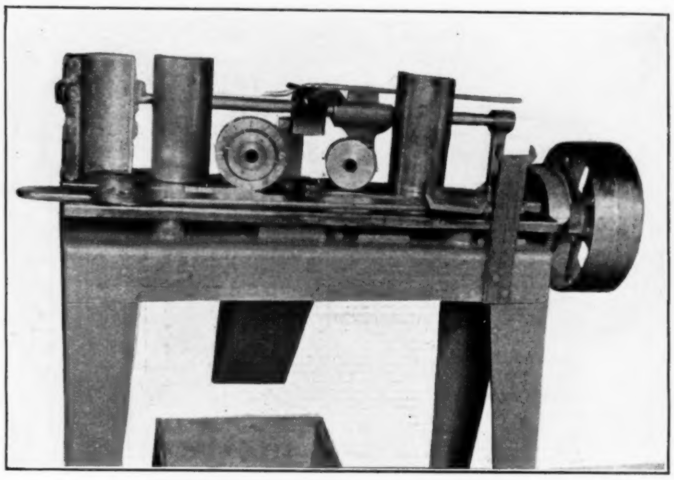


Brass Boring Machine Ready for Operation.

the number of brasses to be rebabbitted, would make possible a much smaller rebabbitting plant, and would greatly reduce the number of brasses carried in stock. Usually the rebabbitting is done at the main shops, which are some distance from the outlying points, necessitating sending the brasses back and forth over the road.

The machine consists essentially of a rotary cutter provided with six teeth. This is mounted on a spindle which may be driven either by a belt or by a motor. The brass is placed on the guide block at the right of the cutter, and is fed over the cutter by pressing down on the lever extending across the machine. The farther end of this lever contains a split nut, which is lifted into mesh with a lead screw; the screw is driven by the spindle through gears, when the operator bears down on the other end. This will feed the brass across the cutter at a uniform rate of speed. The shavings are caught in a box underneath the machine, and may be returned to the babbitting plant for remelting. Incidentally, it has been found that the value of the shavings will more than pay the wages of the operator.

The second illustration shows the apparatus with the various



Brass Boring Machine Showing Guides and Cutters.

removable parts placed on the bed of the machine. Different sizes of cutters and guide blocks will be required for the different sizes of brasses. The guide blocks are held in place by dowel pins and may be easily removed. The shield, which is shown in both illustrations in the raised position, is to protect the operator from injury. It is automatically raised as the shoe passes over the cutter. This machine was designed by Bernhardt Henrikson, Austin, Ill. It is used in the Chicago & North Western shops at Chicago, being driven by a 2 h. p., d. c. shunt motor which is connected to the spindle by a belt.

FREIGHT CAR TROUBLES*

BY C. L. ALDEN,
Foreman Car Repairs, New York Central & Hudson River, West Albany, N. Y.

How often we have repeated, and heard others repeat, the old adage, "a stitch in time saves nine," and yet until recently little attention was paid to this in designing and building freight cars.

Freight traffic is essentially the revenue earner of nearly, if not all, railroads. One would naturally think, therefore, that the designing and building of freight cars would receive the utmost attention to the end that repairs, delays due to repairs, and loss of car service, etc., would be reduced to the minimum. It has been estimated that each day a car is on the repair tracks there is a loss of $2.50 in earnings. At that rate, and assuming that only 10,000 cars a day are on the repair tracks, there would be a yearly loss of $8,125,000 in car service alone. What portion of this sum may be charged to the improper design of the car or its parts? Of course we have no way of knowing, but we do know it is considerable. If it were only as much as 10 per cent. it would total $812,500.

Not enough attention is given to the design of metal end sills. They are made too light and are collapsing wholesale, involving a great deal of labor to repair or renew. Stop castings on metal underframes are defective for the same reason. An eastern railroad is losing practically all grain loading in its cars because

*Entered in the Car Department competition, which closed February 15, 1913.

they leak grain; many of its cars move home empty, while foreign loaded grain cars are hauled over the road.

Ends fail generally because of a lack of proper stays or ties. Some secure the ridge pole to the end plate by a casting and bolts. This is very good so far as it goes, but it does not go far enough. The ridge pole is never very large and the result is that when the end is forced outward the ridge-pole is split—and away goes the end plate. Why not run a plate the whole length of the ridge-pole, and have an angle under it on each end, to fasten to the end plates? Why not run a plate from the corner post back to the door posts and have a tie worth while? Two many seem to think only of the first cost—nothing of future repairs and attendant delays. All-steel ends are on the market having corrugations. These corrugations, as a rule, are elliptical or horizontal. I believe they should be vertical.

Every car having bolts or rods should have them secured by lock nuts *that lock*. Wherever possible, journal box and column bolts should be eliminated. Care should be taken to see that the center channels are not too light. We must get back to some kind of a brake beam safety hanger—and it must not be a chain safety hanger, for they have proved a delusion and a snare. All-metal or metal underframe cars should be provided with drag chains or other provision for chaining the cars together. Many cars which have been derailed are not provided with means for readily chaining the truck to the car in order to raise both simultaneously with a wreck crane to place the car back on the track. This should be done on every car, as there is no other way to readily and expeditiously "do the trick."

On many metal underframe cars there is but 4 in. or 5 in. at the side sill on which to nail side sheathing. This is not enough, and suggest that the sheathing be secured by a small plate of wrought iron and bolts. Brake shafts should be square, or with a square fit for the ratchet wheel, and provision made so that the ratchet wheel will not creep up or down; instead of the shaft bearing being secured to the roof it should be placed on a step.

The car roof is a mooted question. Shall they be of steel outside or inside, plastic, double board, or what? We do find an outside metal roof to be rather dangerous to trainmen, especially when wet or icy. Why not, after painting, provide some kind of rough covering to prevent one's sliding over the surface? We all want a good freight car roof, one that does not leak a short time after its application.

We want a draft gear so designed as to permit the replacement of a broken coupler by two men anywhere in fifteen minutes at a cost of 12 to 15 cents, and we can have it by using a single cross key type of coupler with a suitable draft gear. Why the long delay or shopping of a car at a labor cost of $1.20 when it can be done with slight delay in the train, at one-tenth the cost? Echo simply answers, why? Riveted couplers should be retired as rapidly as possible, along with continuous draft rods, wood brake beams, etc. Some metal underframe cars are designed with truss rods. An underframe that must depend on truss rods is not much of an underframe, and no metal underframe car should be so equipped.

Refrigerator cars should not be so designed that the longitudinal sills are concealed, thus preventing inspection. This is one of the most prolific sources of "no bill" bad order cars. These sills, concealed as they are, are broken, split, decayed, and cannot be detected by inspection; the result is that the draft timbers pull out, taking with them the couplers and attachments, breaking the head blocks, end sills, posts, sheathing, etc., and the delivering company foots the bills.

From a repair standpoint metal cars, or metal underframe cars, should not have center sills in one continuous piece from end sill to end sill. They should be so designed as to permit removal of sections in front of the body bolsters, and these front sections should be of cast steel, and include all necessary draft gear attachments without riveted stops, etc.

There are cars fitted with safety appliances on which the bottom end ladder rung does not coincide with the bottom rung of the side ladder. This should be otherwise, for trainmen come down the end ladder and stand on the pin lifter and end grab iron on the end sill, which is quite a considerable variation from the distance between the ladder rungs. They should be designed to obviate this and venture to predict the roads will make these changes voluntarily for their own interest, as it is positively dangerous.

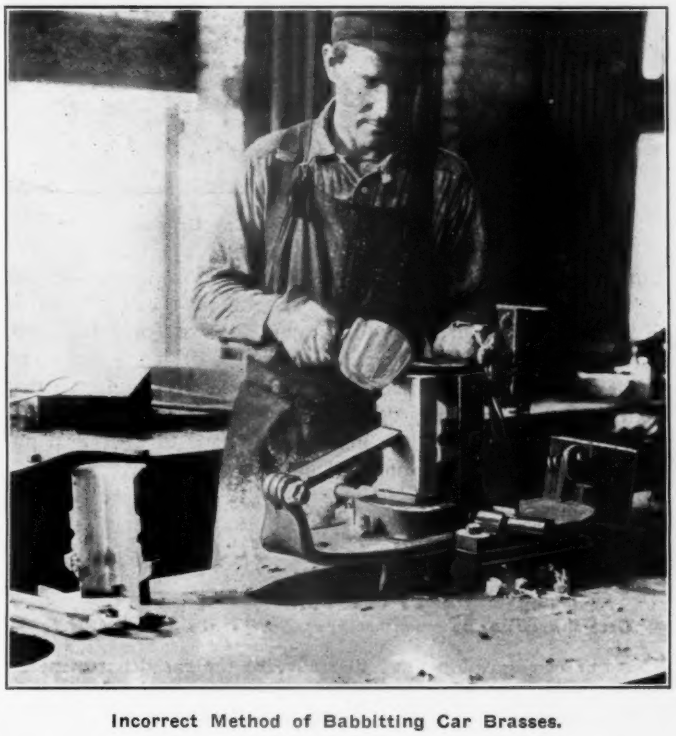
The foregoing are some of the defects which, in my opinion, should be corrected. Of course all bolts on trucks and underframes should be secured by a nut, and a lock nut that grips. Many are lost off, probably due to not having been properly drawn up. There is a type, however, have never seen lost off.

BABBITTING CAR JOURNAL BRASSES

BY E. H. MOREY,
Shop Demonstrator, Chicago & North Western, Chicago, Ill.

Some five or six years ago, when car journals were smaller than they are today, the weight on them less, and the speed of trains not so fast, the journal brass was cast with a pocket for the babbitt and was filled through a hole in the center of the brass. There was no finishing done on this brass before being babbitted and when the journal wore through the babbitt to the lining and began to wear on the rough uneven surface it would cause trouble by running hot. Also, the hole through which the babbitt was poured weakened the brass just where strength was most needed.

About 1907 the design of the brasses was changed. They were



Incorrect Method of Babbitting Car Brasses.

cast with a straight face and bored out smooth, then trimmed and filled while hot on an upright mandrel, the babbitt metal being poured straight down the top end, as shown in the first illustration. The mandrel was kept cold by two ½ in. streams of water constantly running through it. The brasses filled in this way had all appearances of being good, but on taking a light cut over them they were found to be full of blow holes all the way down the center. Some were so bad that the bearing was insufficient at the center of the brass and was increased at the sides where there were no holes, thereby increasing the unit

bearing pressure and causing hot boxes. After considerable investigation it was found that the babbitt was being poured in too fast and after pouring a small stream of babbitt in several brasses it was found that the blow holes were decreased but not altogether eliminated, there still being a streak of holes down the center. By further experimenting it was found that the cause of the holes was the metal carrying air in with it and pocketing it in such a way that it could not get out, consequently the babbitt hardened in this disturbed condition against the cold face of the mandrel.

To overcome this the mandrel was mounted so that it could be swung down, as shown in the second illustration. The metal is now poured in with the brass in this position, the babbitt running down on the brass, which has previously been heated. In this way the babbitt cools more gradually and the air is given a better opportunity to escape. A foot lever is placed under the bench and a counterweight is fixed on the other end of the plate. After a series of experiments it was found that 45 degs. was about the proper amount to tilt the mandrel. To completely fill the brass the mandrel is raised to a vertical position for the last few drops of babbitt.

Correct Method of Babbitting Car Brasses.

FREIGHT CAR DESIGN*

BY C. L. BUNDY,
General Foreman, Delaware, Lackawanna & Western, Kingsland, N. J.

No one can question the importance of the car department on a railroad and the freight car should be given more consideration in a great many cases than it has in the past. The designer should be given ample help and be allowed sufficient time to draw up the specifications and drawings in a thorough manner. Specifications should be clear, concise, and complete in all details. In some cases they are very incomplete; much is left to the builders, who naturally introduce their own standards and methods which are not always to the best interests of the railroad. Builders having no complete and definite specification to go by when making bids are tempted to reduce their manufacturing cost at the expense of material and workmanship so that they will be enabled to submit prices which will be lower than those of their competitors. Past experience has taught us that builders should not be expected, without explicit and definite understanding, to build equipment which will be the best for the service and the most economical to maintain.

More uniformity should be encouraged among railroads in designing equipment, as having as many parts standard or interchangeable as possible, results in a great saving of time and money. It is not uncommon for railroads to hold cars 60 days awaiting material ordered for making repairs to a foreign car. Master car builders at their annual conventions should adopt more standards and follow them in designing new cars wherever it is practical to do so.

When new cars are to be built or purchased the designer should call together the car men from all repair points and learn from them the parts that have shown a weakness in actual service. These men are in a position to observe the actual condition of cars in service and should be given an opportunity to offer suggestions to the designer. In the past designers of freight cars have in a measure failed to design cars to meet the requirements of actual service, and this is especially true of certain parts, the most important of which are as follows:

(1) The ends of cars have shown a decided weakness, especially because of loads shifting in switching service, and should be strengthened.

(2) The roofs have cost the railways vast amounts of money to keep in repair. Also large sums are paid annually for claims on account of goods damaged in transit due to leaky and defective roofs.

(3) Freight car side doors have caused a great deal of trouble and are expensive to maintain; like the roofs they have been responsible for lading being damaged in transit and should be given more consideration in designing new cars.

(4) Some railroads are still applying spring draft gears to cars which are of too small a capacity for the service they are subjected to. These gears should be replaced with high capacity friction draft gears. If this were done it would effect a big saving in the cost of maintenance and a large saving in damaged freight. It would also be the means of keeping cars in service a greater proportion of the time, as there are more cars made bad order on account of defective draft gear than for any other reason.

One of the railroad periodicals has been publishing a series of articles under the head of, "The Growing Cost of Maintenance of Equipment." A study of these articles shows that the draft gears, roofs, doors, and ends of cars are the parts that have been giving railroads the most trouble. If any one doubts this, a visit to the repair tracks will prove the truth of the statement and will show many weaknesses in car construction which would never have existed if the cars had been built to carefully prepared specifications in which first cost was not the only consideration. Therefore, let us design cars with better roofs, better doors, more substantial ends, and better draft gears to meet the service which is required of the freight car of today.

*Entered in the Car Department competition, which closed February 15, 1913.

Public Roads.—The Department of Agriculture reports that in the five years preceding March, 1912, the office of public roads of the department built 215 object-lesson roads; in all about 300 miles of road 15 ft. wide, and by expert advice aided in the formation of more than 650 model county road systems. It has also assisted 26 states in effecting equitable state-aid plans.

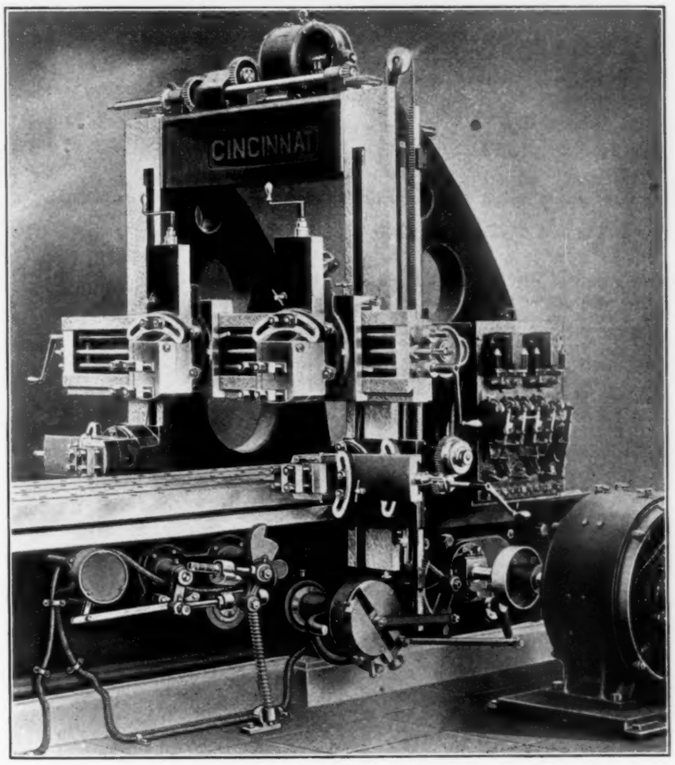
Efficiency of Miners.—The report of the Department of Mines of Pennsylvania shows that in 1902 there were 36,392 miners employed and each had an average output of 8.74 tons of coal a day. In 1911 there were 45,324 miners employed and the average output for each was 7.65 tons a day, a decrease of over one ton a day. This decrease in efficiency means a loss of over 40,000 tons of coal a day.

NEW DEVICES

REVERSING MOTOR PLANER DRIVE

On page 46 of the January issue of this journal appeared a description of a reversing motor drive for planers developed by the General Electric Company. A similar arrangement, but different in some essential features, has been perfected by the Triumph Electric Company of Cincinnati, Ohio. This company began a series of experiments several years ago with a view of developing a special apparatus for meeting the requirements of a direct connected reversing motor planer drive, at first using the type of motor that had been successful in connection with the belt drive. It was soon found, however, that a special design of motor would be required and this has been provided.

The essential difference between the Triumph arrangement and the one illustrated in our January issue, lies in the fact that the former does not employ dynamic braking for stopping the motor.

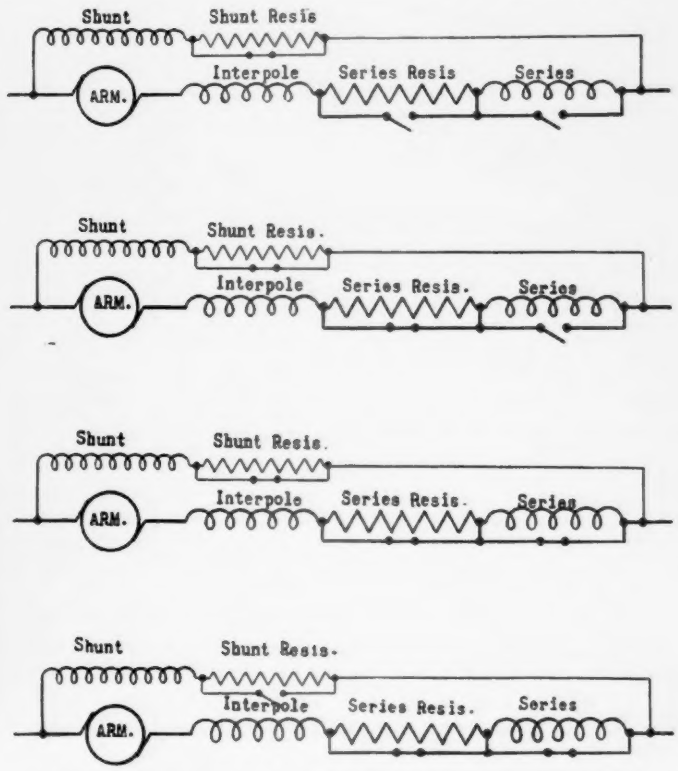


Large Planer Fitted with Triumph Direct Connected Reversing Motor.

In this case the planer is stopped and reversed by disconnecting the circuit to the motor and applying reversed power. It is claimed that this method results in increased speed of reversal, greater uniformity in length of stroke and decreased wear on both the motor and the controller. The reversed power is applied through resistances both for braking and reversing, and it is stated that the peak load never exceeds 50 per cent. overload.

A large panel carries all of the apparatus for automatically accelerating the motor to a predetermined speed in the required direction and for starting and stopping it at every cycle. This is mounted on the side of the planer housing as shown in the illustration. The apparatus on this panel is in duplicate, one-half being for the cutting stroke and the other for the return stroke. It includes, at the bottom, two rheostats for adjusting the speed of the platen on the cutting or return strokes independently. The tumbler handle on the side of the bed is replaced by a master switch and this is connected by a short rod to a reversing switch also on the bed of the planer. Dogs on the table of the machine limit the length of stroke in the ordinary manner.

The master switch is thrown in the direction in which it is desired to have the table move and the switches on the controller automatically connect the motor in the circuit and successively cut out the different resistances and promptly bring the motor to its predetermined speed. The sequence of controller operations, when starting the motor, are illustrated diagrammatically in one of the illustrations. When the master switch handle is turned in either direction, the motor armature is connected in the circuit through resistances as are shown in the diagram at the top of the illustration. The series resistance is first cut out and the motor then operates as a compound, interpole machine with full field strength. The series field coil is next short-circuited and the motor then becomes a shunt, interpole machine still retaining the full shunt field strength. The shunt resistance short-circuiting switch is then opened as shown in the last diagram which causes the motor to attain its predetermined speed. When the trips on the platen reverse the master switch the switches return to their initial position and power is immediately applied in the reverse direction. It requires but one second from the time the master switch is thrown until the last switch operation for the full speed of motors is made. When the master switch is brought to the vertical position the motor and table are immediately stopped.



Sequence of Connections on Starting or Reversing the Motor.

The speed of either the cut or return may be quickly varied in small steps, without stopping the planer, by a slight movement of the tumbler. Edging in ½ in. strokes is also easily accomplished and it is claimed that the length of the stroke is accurate to within ⅛ in. on cuts of any length or speed, making it possible to plane in pockets or close to ledges.

GASOLENE CARS FOR THE HOLTON INTERURBAN

The Holton Interurban, Redlands, Cal., has recently placed in service a type M-6 gasolene motor car made by the Hall-Scott Motor Car Company, San Francisco, Cal. This is the second Hall-Scott motor car purchased by this company, a type M-4 having been placed in service about two years ago. The power plant consists of a six-cylinder gasolene engine of 150 h. p. capacity, and has a speed range of from 4 m. p. h. to 60 m. p. h. in four stages in either direction. This flexibility of speed control will permit of yard switching and of the handling of one or more trailers, dependent, of course, on grade conditions.

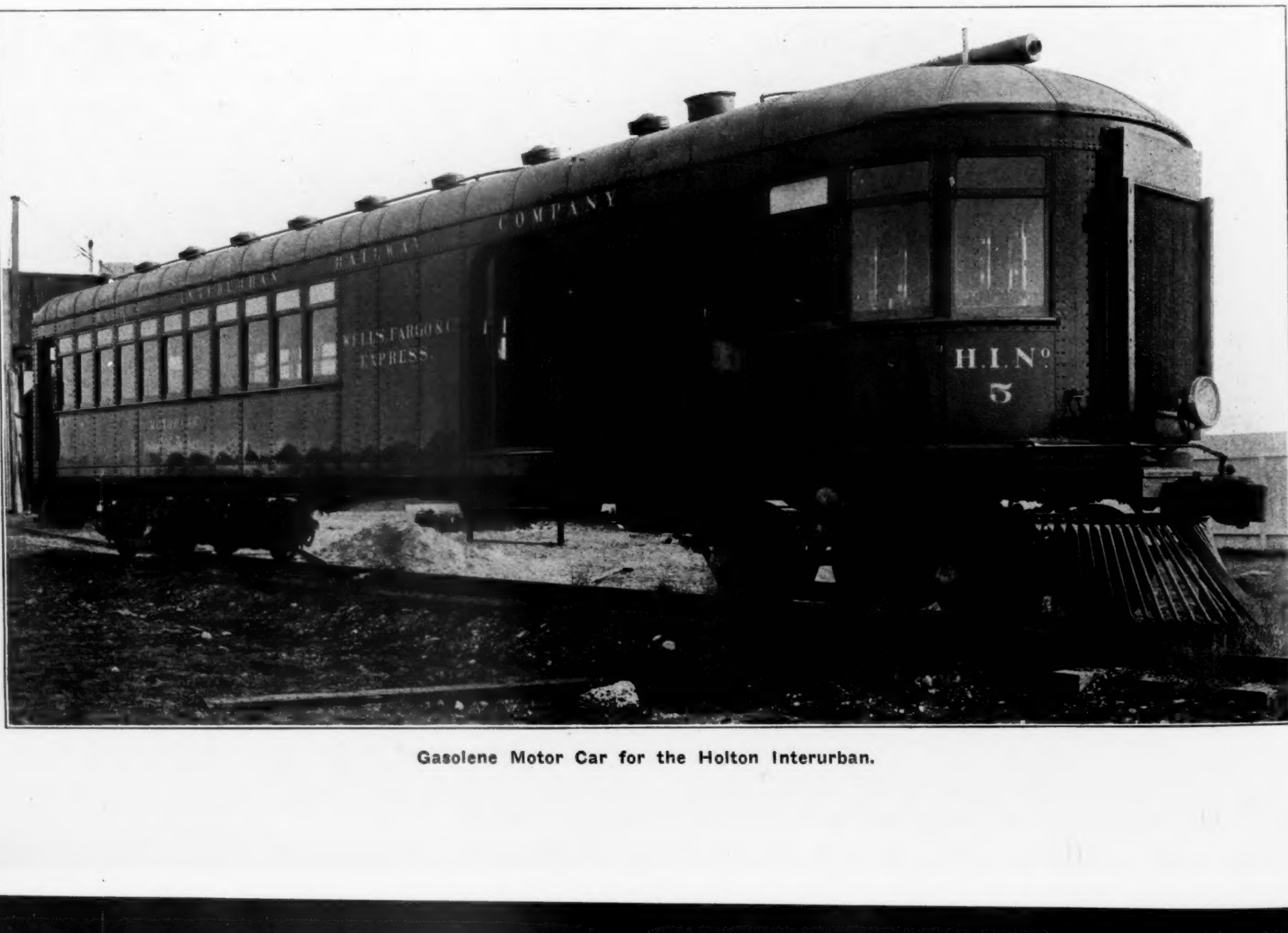
Hall-Scott Gasolene Motor Car Hauling Twelve 20-Ton Beet Cars.

The car is of steel construction, the steel body, trucks, gasolene motors and driving mechanism being designed and built in the builders' factory at West Berkeley, Cal. It is 60 ft. long over end sills and has a seating capacity for 64 passengers in the main passenger compartment. The baggage room is 16 ft. long and is equipped with lift wall seats for eight additional passengers. Baggage and mail may also be carried in the engine room, a space 12 ft. long by 3 ft. wide being available for that purpose. The total weight of the car is 67,850 lbs.

During the first three months of service this car made an average of 75.6 miles per day. The following table gives the operating cost during this time.

RESULTS OF OPERATION FOR THREE MONTHS ENDING FEBRUARY, 1913.

	1912.	1913			
	December	January	February	Average	Average cost for car operating under ordinary conditions
No. miles traveled	2,238	2,458	2,138	2,278	......
No. miles traveled per day	72	79	76	75.6	......
Gallons gasolene used	767	785	725	759	......
Gallons gasolene used per mile	0.342	0.319	0.339	0.333	......
Cost gasolene per gallon	0.23	0.215	0.215	0.22	0.10
Cost gasolene per mile	0.079	0.068	0.073	0.074	0.033
Total cost gasolene	$176.41	$168.77	$155.87	$167.02	$75.90
Gas engine oil used	26	37	24	29	......
Cost gas engine oil per mile	0.006	0.0078	0.0058	0.0066	0.005
Cost gas engine oil per gal.	0.52	0.52	0.52	0.52	0.40
Engine oil per mile	0.011	0.015	0.011	0.012	......
Total cost engine oil	$13.52	$19.24	$12.48	$15.08	$11.60
Machine shop bill	33.35	31.90	27.15	30.80	......
Cost repairs per mile	0.0149	0.013	0.0126	0.0135	0.0135
Cost operators per mile	0.089	0.081	0.093	0.087	0.087
Total operative cost per mile	0.189	0.169	0.184	0.181	0.1385



Gasolene Motor Car for the Holton Interurban.

Operator's cost figured on basis of $125.00 per month for motorman.
Operator's cost figured on basis of $75.00 per month for conductor.
Note that cost of gasolene and oil is excessive on account of the car being operated so far from distributing points for oil and gasolene. The last column at the right shows the operating cost for the car on the basis of Eastern prices for oil and gasolene.

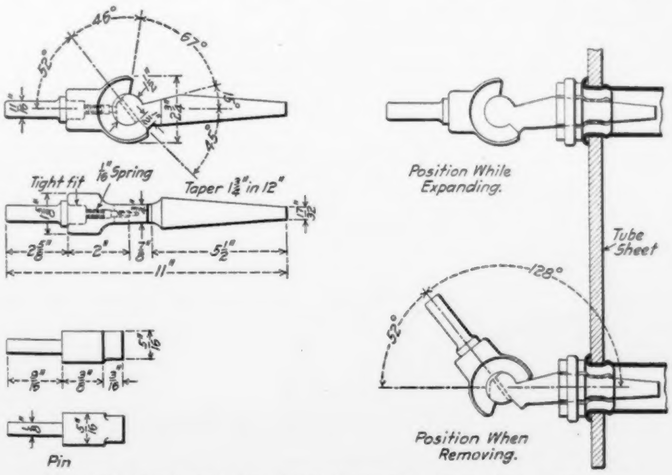
The engine is mounted directly on the center sills of the car underframe. The clutch is of the contracting band type. The transmission is hung on the forward axle of the rear truck, and the axle is driven through a train of bevel and spur gears of hardened forged steel. The operating levers are placed on the right hand side of the car in a position convenient for the operator, being similar in their functions to automobile practice. The circulating water is cooled by a radiator placed directly in front of the car, as shown in the illustration, which provides a positive thermo-syphon circulation of the water and a ready means of completely draining the whole circulating system. A cooling fan is placed directly back of the radiator.

One of the illustrations shows another car of this same type, built for the Ventura County Railway, handling 12 side dump beet cars which have a tare weight of about 20 tons each. This motor car also hauls one of the road's standard coaches, as a trailer, in regular service.

Both these cars are equipped with the Westinghouse automatic and straight air brake systems; a double-cylinder water cooled air compressor directly driven from the main engine; and an electric generator, also driven from the main engine, which charges the storage batteries for lighting and starting the main engine.

MANDREL FOR SECTIONAL TUBE EXPANDERS

In order to remove the mandrel or pin from a sectional tube expander, it is generally struck with a hammer to loosen it. This is likely to cause the edges to break and fly, and serious injury may result to the operator. A new type of expander pin is shown in the illustration. It is designed for operating with either a short or long stroke pneumatic hammer in shop and roundhouse work. The tube is expanded by driving the pin into the expander in the usual manner. For releasing the pin,



Mandrel Designed for Easy Removal from the Expander.

the knuckle joint is swung around to the position shown and a few taps with the hammer in this position loosen it and permit its easy removal. One of the features of this pin is that it can be used by the operator without separating the pneumatic hammer from the shank of the pin, thus eliminating the danger of possible injury from flying pieces, as well as saving time. The knuckle joint is made with ample bearing surface to prevent wear and does not interfere in any way with the working of the expander. This pin was devised by H. Neville, and is made by the Faessler Manufacturing Company, Moberly, Mo.

DUPLEX SPRING CLIPS FOR TRACING FILES

Comparatively few special devices have been introduced in railway drawing rooms for protecting tracings from damage and wear by handling. A spring clip for tracing files, blue print files and various kinds of loose leaf devices, which has been recently put on the market by G. G. Dana, 2311 Washington avenue, Racine, Wis., is shown in the illustration. The double or duplex spring, as the name implies, gives a pressure on the contents of the file preventing them from slipping about while the portfolio is being handled. It also prevents tracings from becoming curled or folded on the upper edge; without the clips they become worn and creased on the edges and corners, making them hard to handle in making blue prints and a source of general annoyance to the users.

The clip is so shaped that a tracing, blue print or sim-

Special Clips for Holding Tracings in Portfolio.

ilar article may be easily slipped into its place or removed therefrom. Any sheet in the group may be removed without disturbing the remaining portions. An important advantage of the clip is the protection it gives to tracings in preventing the curling and folding over of the edges and corners. The clips are made of polished steel, are neat in appearance and convenient in use. They are attached to the back cover of the portfolio by clinch rivets.

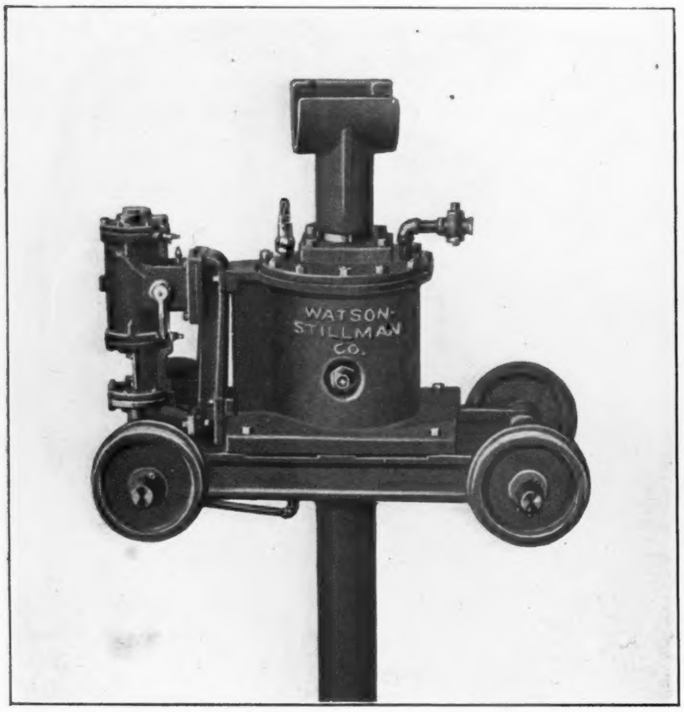
HYDRAULIC PIT JACK

An improvement has been made in the construction of hydraulic pit jacks by the Watson-Stillman Company, New York. The hand-operated pumps have been replaced by pumps driven by air engines, and to make the power connection it is merely necessary to run a rubber hose or other flexible tubing from the shop air main to the pump engine. The operating valves may be placed in any convenient position, and the use of the compound air engine eliminates the necessity of having a pump operator.

By the use of air power the speed of operation is greatly increased. When it is desired to raise the saddle, air is admitted directly into the top of the reservoir, forcing the water into the

cylinder and lifting the ram. As soon as the load becomes too great for this pressure, the air is by-passed into the air engine, which in turn lifts the ram.

In the jack illustrated the ram raises at the rate of 7½ in. per min., whereas only 2 in. per min. is attainable with a hand

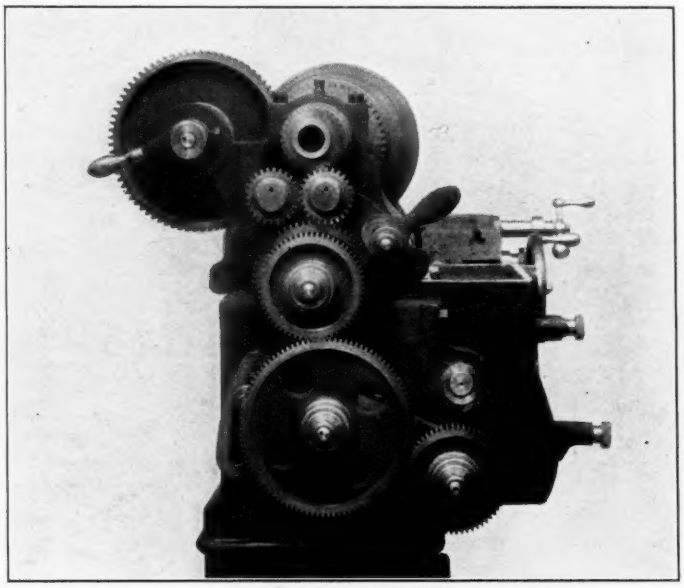


Hydraulic Jack for Use in Drop Pits.

power pump. It has a lifting capacity of 10 tons and a total lift of 103 in. The ram is telescopic in two lengths, 4 and 5 in. in diameter, respectively.

HEAVY ENGINE LATHE

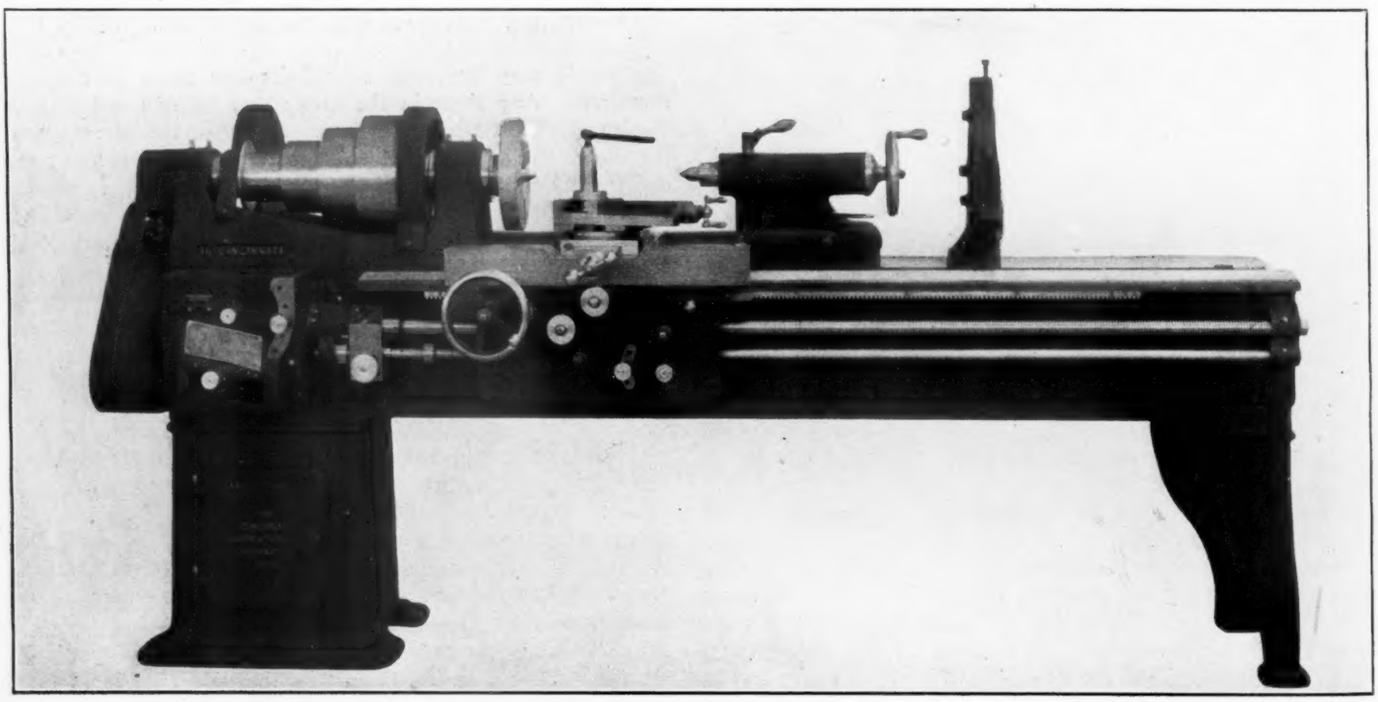
Notable among the recent improvements in engine lathes is the quick change gear lathe, made by the Cincinnati Lathe & Tool Company, Cincinnati, Ohio. There is an arrangement on it by which a combination of extra or metric pitches with a U. S. standard lead screw, or vice versa, is possible. The standard threads may be changed from one to another without duplicating or removing a gear by simply operating two levers. This gives the machine a very wide range. The device is complete in one unit, being assembled in a box mounted on the



End of Cincinnati Lathe With Gear Cover Removed.

front of the lathe. It provides the facilities of a standard lathe, and each gear will cut not only the pitch required, but through the series of gear box changes will give others as well.

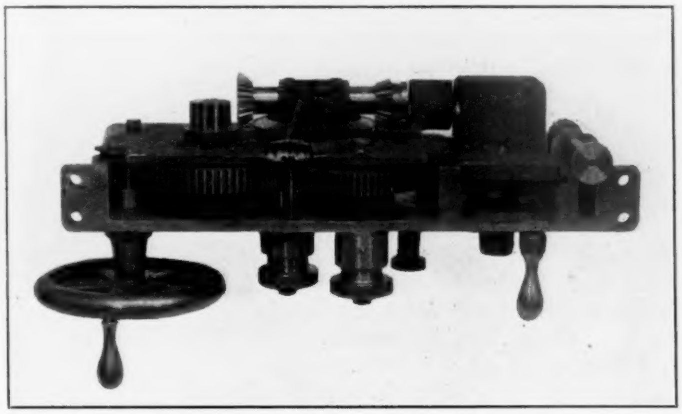
The bed of the lathe is made of semi-steel, being designed to give the necessary rigidity under heavy cuts. The headstock is made in three styles, one with a three-step cone and double back gears, and with the four or five-step cones with single back gears. The spindle is made of high carbon forged steel and is provided with a collar on the chuck end, which gives a good, stiff bearing. The thrust bearing at the rear end of the spindle consists of a hardened tool steel collar arranged



Cincinnati Quick Change Gear Lathe.

for adjusting the wear, the thrust being taken against the front end of the rear box. The spindle bearings are lubricated by self-enclosing dust proof oilers.

The apron is of the box type construction, being rigidly bolted to the carriage. The rack pinion is made of steel and is operated by compound gearing. The longitudinal and cross friction feeds may be started, stopped, or reversed while the lathe is running, but they cannot be engaged when the lathe is set for cutting screws. A thread chasing dial is provided which permits the half nuts to be opened, the carriage to be run back by hand and the thread to be picked up at any point, thus doing away with the necessity of reversing the lathe for this purpose. An automatic stop is also provided for throwing out the feeds.



Feed Gears of Cincinnati Lathe.

The reverse plate for cutting right and left hand threads is on the outside of the headstock, and is used only for reversing the lead screw when cutting threads and not for reversing the feed. These machines have the feed reverse in the apron. The screw cutting and feed mechanism shafts are bushed throughout with bronze.

The tailstock has a long bearing on the bed, and is made to withstand the severe treatment of heavy work. It is of the offset type, allowing a compound rest to be set in a plain parallel with the bed. The tailstock spindle is of large diameter, and is equipped with a bronze nut for the lead screw. A special clamping device is used to hold the spindle in position instead of the split barrel construction. All gear changes may be made while the gear is running under heavy cut.

IMPROVED TYPE OF CORRUGATED TUBES

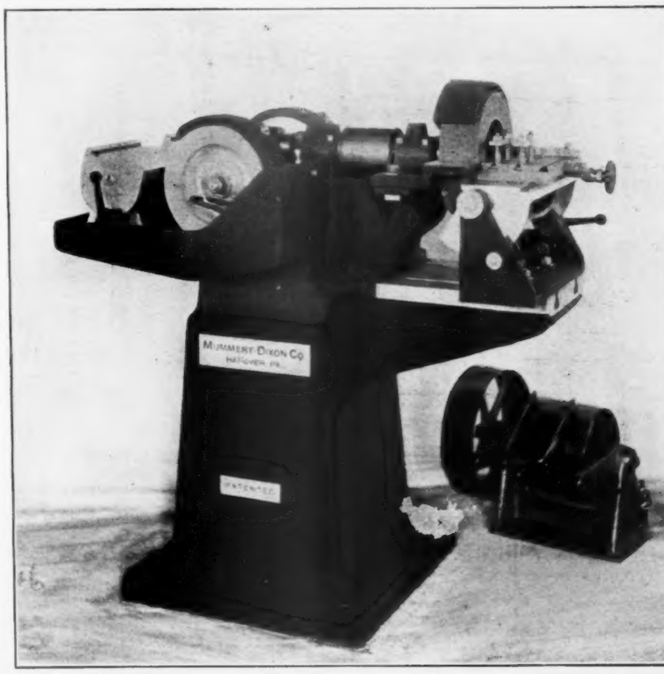
An improved process for making corrugated tubes has been developed by Mr. Maciejewski, a Polish engineer, in which standard wrought iron or steel tubes are used. The corrugations are made by an ingenious method of pressing the material together in such a way that, while shortening the tubes, the original inside diameter is not decreased. Furthermore the thickness remains absolutely uniform and is the same as in the original tube. During the process of corrugating, any defects in the material at once become apparent. In this process small and medium sized tubes are made from ordinary steel tubing, while for large diameters lap welded and re-rolled tubes are used. Tubes of any diameter from 1⅜ in. to 18 in. may be corrugated; very long tubes may be partially corrugated.

Tubes of this type are adapted for use where expansion due to a considerable range of temperature has to be absorbed, or where a large external stress must be resisted. They are sometimes used in fire-tube boilers, especially where very long tubes are required. In such cases the corrugations, by taking up the expansion, relieve the tube sheets from carrying the strain. The principal field of usefulness, however, is in connection with steam piping. In short lines of pipe a straight corrugated tube will take care of the expansion satisfactorily, while in longer lines of pipe a corrugated tube bent in U shape is required. Tests have shown that a bend made of corrugated pipe will absorb over three times as much expansion as will the same size bend made of straight pipe.

Mr. Maciejewski's process has been patented in the United States and is controlled by Schuchardt & Schutte, 90 West street, New York.

OILSTONE TOOL GRINDER

A new design of tool grinder which has two oilstones, one coarse and one fine, as well as a ring emery wheel, has been designed by the Mummert-Dixon Company, Hanover, Pa. This grinder is especially adapted for tool room work and has two oilstone wheels mounted on the front arbor. In connection with each is a tool rest which can be adjusted to any angle desired and is held by a convenient locking device. These wheels are cup shaped and the oil is directed to the inside of the wheels and is passed out through the pores. When the wheels are once saturated they require very little oil. There is a guard to prevent the oil being thrown off the wheels and any surplus is caught in a pan and returned to the reservoir. Kerosene is employed and is handled by a rotary pump which takes its supply from the reservoir in the base of the machine. This keeps the stones sharp and prevents glazing and also protects tools from undue heating while being ground.



Tool Grinder with Two Oilstones and an Emery Wheel.

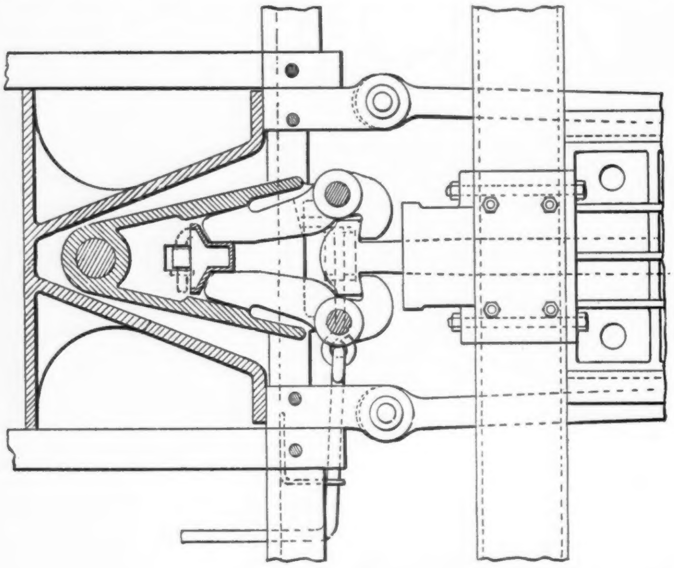
At the back of the grinder there is the ring emery wheel which operates at four times the speed of the oilstones. A slide is provided in connection with this wheel which has a micrometer adjustment and can be arranged for grinding at any angle. The table is arranged so that any part of the wheel can be readily used.

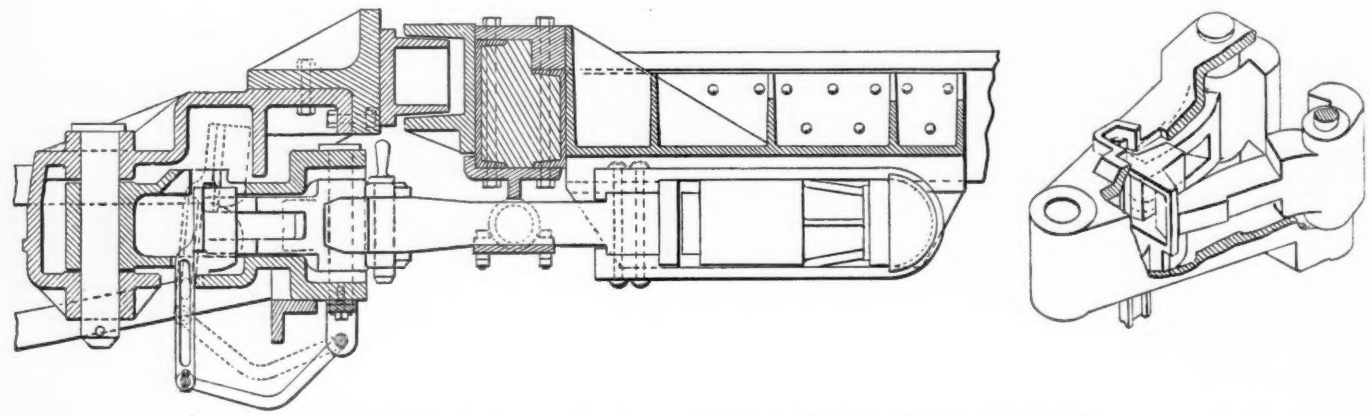
The machine shown in the illustration is arranged for belt drive, but when a motor drive is desired, the motor is mounted in the base of the machine and belted directly to the pulley.

THIRD-CLASS SLEEPING CARS IN NORWAY.—Norway follows the example of Sweden in ordering some third-class sleeping cars. They have three berths to a section, each 24 in. wide, and there are 12 sections to a car. These cars will weigh 76,000 lbs.

ENGINE AND TENDER COUPLER

A form of connection between locomotive and tender, which permits the use of a spring or friction draft gear on the front end of the tender, has been developed on the Santa Fe. This connector includes an operating gear and can be connected and disconnected in the same way as an automatic car coupler. It has been in experimental use on a large Mallet locomotive for over two years, and during this time has not developed any faults of consequence. On one occasion the locomotive was derailed by a split switch, but even under this condition the coupler did not separate. It has been found of great convenience at the engine house to be able to connect and disconnect the tender from the locomotive easily and quickly. The use of a suitable draft gear at the front end improves the riding qualities of the locomotive to some extent, and probably has a favorable influence in preventing any tendency toward derailment of the tender trucks.





Automatic Connector Between Engine and Tender; Atchison, Topeka & Santa Fe.

This arrangement, which has been perfected by M. J. Drury, shop superintendent, and G. W. Wright, consists of a special drawhead on the locomotive of the form and arrangement shown in the illustration. This drawhead can either be included in the deck casting or may be applied to a locomotive arranged for the ordinary type of drawbar. A pair of special shaped knuckles with long tails are hinged on each side of the outer end of this drawhead. Between the tails of the knuckles is a locking block which is allowed a vertical movement and passes through an opening in the top of the drawhead when in the uncoupled position. This block is connected to the operating gear through an extension on the bottom and suitable lugs are arranged so that when it is lifted to the full height it is automatically held unlocked in the same manner as the pin of a car coupler. This permits the tails of the knuckles to swing inward.

The inner faces of the knuckles where they connect to the drawhead on the tender are arranged at such an angle that most of the stress in pulling comes on the pins on which the knuckles swing and comparatively little pressure must be resisted by the locking block at the rear. This angle, however, is not so great but that the pull on the knuckle will tend to force the tail portions together when the locking block is raised. One of the knuckles has a slotted section at the rear of proper size to admit the tail of the other, so that the faces of the two knuckles will separate sufficiently to allow the tender drawbar head to disengage.

Starting with the uncoupled position when the locking block is held in its raised position by the lugs, as is shown by the dotted line in the illustration, and the knuckles are open at the face to allow the drawbar on the tender to pass between them; the operation is as follows: The special shaped drawhead on the tender, after passing between the knuckles, will strike the inwardly extending portions of the tail and tend to force them apart. This action continues until the tails are sufficiently far apart to allow the locking block to enter between them. Just before they reach this position the beveled face of an extension on the block is engaged and it is released from its disengaged position at the top and drops between the tails of the knuckles. The faces of the knuckles are then locked behind the lugs on the tender drawhead and the apparatus is securely connected. The locking block is of considerable weight and any jarring of the locomotive will only tend to hold it more firmly in position. When uncoupling, the locking block is lifted by the uncoupling gear and when fully raised tilts forward and locks itself in that position. The pull on the tender drawbar then forces the tails of the knuckles together until the faces are disengaged and the coupler is separated.

Large Hanna Type Riveter.—A yoke riveter with a gap of 168 in. in depth and 12 in. in width, which will exert a pressure of 100 tons on the rivet with 100 lbs. air pressure in the air cylinders, has recently been installed by the General Electric Company at its Pittsfield, Mass., shops. It was built by the Hanna Engineering Works and has an air cylinder 18 in. in diameter with a 22 in. stroke. It operates by means of a combination toggle and leverage action which is followed by a plain leverage action. The plunger and upper die of the machine has a movement of $5\frac{3}{4}$ in.; $4\frac{3}{4}$ in. of this distance is traversed during the first 11 in. of the stroke of the air cylinder, while the remainder of the stroke gives but 1 in. movement of the plunger. This last 1 in. is given at a uniform travel and pressure, and it is stated that this gives the machine all the advantages of a hydraulic riveter without the disadvantages of the very high hydraulic pressure and the necessity of a return line.

NEWS DEPARTMENT

At a "Safety rally" of employees of the Buffalo, Rochester & Pittsburgh, held at DuBois, Pa., on April 12, three thousand persons were present.

President B. L. Winchell, of the Frisco lines, traveled 55,394 miles in 1912, and 59,173 miles in 1911. During 1912 he attended seventy-five meetings, which included banquets and conferences.

The United States Civil Service Commission announces competitive examinations, to be held May 21 and 22, 1913, for the positions of structural steel draftsman, copyist marine engine and boiler draftsman and assistant engineer in forest products.

The safety department of the Chicago, Burlington & Quincy, of which E. M. Switzer is the superintendent, has had a car fitted up especially for use in the "safety first" campaign. It is arranged similar to a small theater, having seats for 70 persons, and a platform with a large screen on which moving picture views will be shown during lectures to be given by Mr. Switzer. Lectures will be given from this car at prominent points on all parts of the Burlington system, the purpose being to have the car go to the men, instead of requiring the men to go to a hall to attend the lectures.

Sixty-nine apprentices were graduated between January 1 and December 31, 1912, from eight shops on the New York Central Lines West of Buffalo at which apprentice schools are maintained. These shops include Beech Grove and Bellefontaine on the Big Four; Collinwood and Elkhart on the Lake Shore & Michigan Southern; Gibson on the Chicago, Indiana & Southern; Jackson and St. Thomas on the Michigan Central, and McKees Rocks on the Pittsburgh & Lake Erie. The trades represented were as follows: Machinists, 53; boiler makers, 4; blacksmiths, 3; tinners, coppersmiths and pipe fitters, 4; pattern makers, 2; painters, 1; electricians, 1; car builders, 1. Of the sixty-nine, 62, or 90 per cent., remained a service for at least 60 days after graduation, and 57, or 83 per cent., are still in service. Apprentice schools have recently been established at Bucyrus on the Big Four and Kankakee on the C. I. & S. There are now 466 apprentices in shops on the New York Central Lines West of Buffalo which maintain apprentice schools, as compared with 380 one year ago.

THE LATEST THING IN SIGNS

The Chicago & North Western has installed a novel electric advertising sign over the river front in Chicago, facing the Rush street bridge. The sign measures 50 ft. square, and shows a large passenger locomotive and part of a train. In front of the locomotive is a semaphore signal which automatically changes from the stop position to the clear position. When the change has been made the driving wheels of the locomotive are seen to revolve and a small ribbon of smoke is emitted from the stack. When the signal goes back to the stop position the wheels slow down and stop. Surmounting the sign is a large trade mark of the company in colors, and underneath the train are a few lines of advertising of its service. The sign stands on the roof of one of the company's freight houses, and is so located that it is seen by thousands of people. The sign contains 3,800 tungsten lamps, 29,500 lbs. of steel and 30,000 ft. of wire. Its total weight is 18¾ tons.

SPEED RECORDERS ON THE BALTIMORE & OHIO

The through passenger trains of the Baltimore & Ohio are now equipped with speed recorders, two to a train; one in the baggage car and one in the locomotive. In the baggage car the "Haushalter" speed tape is used, while on the locomotives the Boyer speed recorder is used. Both of these machines make records on tapes. At the end of each trip the tape is taken out by the local inspector, who makes a suitable record of the date, time, etc., and sends the whole to the office of the general inspector of transportation, where a permanent record is kept. The information given on the tapes is checked against the rates of speed prescribed in the rules limiting speed at different points on the road, so that excessive speed is at once brought to notice. The maximum speed of passenger trains on the Baltimore & Ohio, except between Philadelphia and Washington, is 60 miles an hour, and the officers require a rigid observance of the limit. On the Philadelphia-Washington line the limit is 65 miles an hour.

PENNSYLVANIA PENSIONS

The Pennsylvania Railroad has now paid pensions 13 years, and a total of 7,152 men have received payments, through the funds, of $8,368,786, all out of the earnings of the various companies in the system. Of this amount $6,319,902 has been paid on the lines east of Pittsburgh, and $2,048,884 west of Pittsburgh. At the present time there are 3,807 men on the pension rolls. The names, occupations, and divisions where last employed of those over ninety years of age were as follows:

Name.	Occupation.	Division.
Micheal Eckerline	Laborer	Altoona shops.
James Kaylor	Blacksmith	Altoona shops.
Elias Griffith	Watchman	Altoona shops.
James L. Shields	Foreman mason	Conemaugh.
David L. Graeff	Machinist	Philadelphia.
Thomas C. Payne	Laborer	Trenton.
Charles Lupton	Car builder	Philadelphia Terminal.
James Gray	Agent	Elmira.
Chas. A. Jefferies, Sr.	Signal repairman	Philadelphia.

The pension amounts to 1 per cent. of the average salary or wage for the ten years previous to retirement, multiplied by the number of years the man has been in the employ of the company. Employees retire without any obligation whatever to the Pennsylvania Railroad, and many of them engage in outside occupations. This pension plan, inaugurated by Mr. Cassatt in 1899 with much doubt as to its eventual success, is now declared by the officers of the company to have proved to be of immense benefit to a large number of men, and to have contributed enormously to the contentment of the men in the service of the road.

FIREMEN'S ARBITRATION AWARD

The award of the arbitrators between the eastern railroads and their firemen was filed April 23, 1913, and in accordance with the provisions of the Erdman act, will take effect ten days later. The following are the terms of the award:

Article 1: Ten hours or less, or one hundred miles or less, shall constitute a day's work in all classes of service, except as otherwise specified. The time for which firemen will be paid shall begin at the time he is required to report for duty, and end when the engine is delivered at the point designated.

Article 2: The following rates of wages per day shall be the minimum rates paid in all classes of service on all railroads, parties to this arbitration:

(a) PASSENGER SERVICE.

Weights of Locomotives in pounds on Drivers.	
Less than 80,000 lbs.	$2.45
80,000 to 100,000 lbs.	2.50
100,000 to 140,000 lbs.	2.60
140,000 to 170,000 lbs.	2.70
170,000 to 200,000 lbs.	2.85
200,000 to 250,000 lbs.	3.00
250,000 to 300,000 lbs.	3.20
300,000 to 350,000 lbs.	3.40
All engines over 350,000 lbs. on drivers	3.60
Mallet engines regardless of weight on drivers	4.00

FREIGHT SERVICE.

Less than 80,000 lbs	$2.75
80,000 to 100,000 lbs	2.85
100,000 to 140,000 lbs	3.00
140,000 to 170,000 lbs	3.10
170,000 to 200,000 lbs	3.20
200,000 to 250,000 lbs	3.30
250,000 to 300,000 lbs	3.55
All engines over 300,000 lbs. on drivers	4.00
Mallet engines regardless of weight on drivers	4.00

Where two firemen are employed on a locomotive as a result of the application of Article 6 hereinafter, the rates of pay to each fireman shall be as follows:

Weight on drivers, 100,000 up to 250,000 lbs	$2.75
Weight on drivers, over 250,000 lbs	3.00

(b) SWITCHING SERVICE.

Switch engine firemen on locomotives weighing less than 140,000 lbs. on drivers, per day of ten hours or less	$2.50
Switch engine firemen on engines weighing 140,000 lbs. or over on drivers, per day of ten hours or less (excluding Mallets $4.00)	2.60

(c) HOSTLERS.

Hostlers, per day of ten hours or less	$2.40
If hostlers are employed in handling engines between passenger stations and roundhouses or yards, or on main tracks, they will be paid, per day of ten hours or less	3.25
If men are employed to assist hostlers in handling engines between passenger stations and roundhouses or yards, or on main tracks, they will be paid, per day of ten hours or less	2.50

(d) HELPER ON ELECTRIC LOCOMOTIVE.

The term "helper" will be understood to mean the second man employed on electric locomotives, and he shall receive in passenger service, per day of ten hours, or less, one hundred miles or less	$2.50
In through freight per day of ten hours or less, one hundred miles or less	2.80
In switching service, per day of ten hours or less	2.50

All working conditions applicable to steam locomotive firemen in steam service will apply to helpers in electric service.

(e) Firemen on locomotives in pusher and helper service, mine runs, work, wreck, belt line and transfer service, and all other unclassified service will be paid through freight rates according to the class of engine.

(f) Firemen in local freight service will be paid fifteen cents in addition to through freight rates according to class of engine.

(g) For the purpose of officially classifying the locomotive, each railroad, party to this arbitration, will keep bulletins posted at all terminals showing accurately the weight on drivers of all engines in its service.

Article 3: (a) Overtime in all classes of service, except passenger, will be paid for pro rata on the minute basis. Except as otherwise specified ten hours, or one hundred miles will be the basis for computing overtime. Miles and hours will not be counted together; when miles exceed hours, miles will be allowed, and when hours exceed miles, hours will be allowed.

(b) Overtime in passenger service (except suburban service) will be paid at the rate of thirty cents per hour on the basis of twenty miles an hour, computed on the minute basis. Five hours or one hundred miles or less, to constitute a day's work.

(c) On short turn around runs, no single one of which exceeds eighty miles, including suburban service, overtime shall be paid for all time actually on duty, or held for duty, in excess of eight hours (computed on each run from the time required to report for duty to end of that run) within twelve consecutive hours; and also for all time in excess of twelve consecutive hours, computed continuously from the time first required to report to the final release at the end of the last run. Time shall be counted as continuous service in all cases where the interval of release from duty at any point does not exceed one hour.

Article 4: No initial terminal delay is allowed beyond that involved in the rule that pay shall begin in all cases at the time fireman is required to report for duty, but final terminal delay after the lapse of one hour will be paid for at the end of the trip, at the overtime rate, according to the class of engine, on the minute basis. For freight service final terminal delay shall be computed from the time the engine reaches the designated main track switch connecting with the yard track. For passenger service final terminal delay shall be computed from the time the train reaches the terminal station. If road overtime has commenced terminal overtime shall not apply, and road overtime shall be computed to the point of final release.

Article 5: Firemen in pool freight and in unassigned service held at other than home terminal, will be paid continuous time for all time so held after the expiration of eighteen hours from time relieved from previous duty, at the rate per hour paid him for the last service performed. If held fourteen hours after the expiration of the first twenty-eight hour period, he will be paid continuous time for the next succeeding ten hours, or until the end of the twenty-four hour period, and similarly for each twenty-four hour period thereafter. Should a fireman be called for duty after pay begins, his time will be computed continuously.

Article 6: When a second fireman is deemed necessary on any engine or assistance is deemed necessary on any engine where one fireman is employed, the matter will be taken up with the proper officials by the Firemen's Committee. Failing to reach a settlement the matter shall be referred to an Adjustment Commission, to be composed of five persons, two of whom are to be chosen by the railroad, two by the Firemen's Committee, and one to be selected by the four thus chosen, who shall be the chairman of the commission. Should the four men fail to agree upon the fifth, then three days after the last of the four is selected, the fifth man shall be named by the presiding judge of the United States Commerce Court. If, for any reason, the selection of the fifth man cannot be made by the presiding judge of said court, he shall be named by the United States district judge of the district in which the controversy may have arisen. All expenses incurred in connection with the settlement of such matters shall be borne equally by the two parties to the controversy.

Article 7: Firemen will be relieved of cleaning engines. Lubricators will be filled, headlights, markers and other lamps cared for (including filling but not lighting), and all supplies placed on engines at points where roundhouse or shop force are maintained. The firemen shall not be relieved of responsibility of knowing that engines for which they are called are properly equipped for service.

Article 8: Firemen tied up between terminals on account of the hours of service law, will be paid continuous time from initial point to tie-up point. When they resume duty on a continuous trip they will be paid from tie-up point to terminal on the following basis: For fifty miles or less, or five hours or less, fifty miles pay; for more than fifty miles up to one hundred miles, or over five hours, and up to ten hours, one hundred miles pay; over one hundred miles, or over ten hours, at schedule rates. This provision does not permit the running of firemen through terminal or around other firemen at terminals, unless such practice is permitted under the pay schedule.

Article 9: The earnings of firemen in any class of service shall not be diminished by the provisions of this award; and if the rates that were higher or the conditions that were better antecedent to this award are necessary to guarantee this requirement they shall be maintained. Neither shall the earnings of the firemen, in any class of service, be increased above what the higher rates of pay and the conditions that were better antecedent hereto guaranteed him, by a combination of the rates herein established with the conditions of service antecedent hereto, or vice versa.

It is not intended that any of the terms or provisions of this award shall debar committees from taking up for adjustment with the management of the respective railroads any questions or matters not specifically covered herein.

Article 10: This award shall take effect at the time and in the manner provided by the act of congress entitled "An Act Concerning Carriers Engaged in Interstate Commerce and Their Employees, Approved June 1, 1898." All parties to this arbitration having stipulated in writing, and incorporated in the record an agreement, extending the time within which the award may be made and filed, from the second day of April, 1913, to and including the twenty-third day of April, 1913, the arbitrators now, on this twenty-third day of April, 1913, signed this award without dissent in any particular to any of its provisions by any one of them, and have required the secretary to attest the same.

MEETINGS AND CONVENTIONS

Western Canada Railway Club.—H. D. Cameron, chief draftsman, mechanical department, Canadian Northern, presented a paper on the hauling capacity of locomotives at the March meeting. He discussed the resistances that enter in the operation of locomotives and cars, and recommended certain reductions in tonnage rating for low temperatures. It was pointed out that most economical trainloading is something that must be finally determined by experiments with a dynamometer car.

Master Car and Locomotive Painters' Association.—The forty-fourth annual convention will be held at the Chateau Laurier, Ottawa, Canada, September 9 to 12. Papers will be presented on the following subjects: Railway Paint Shop Supplies; Finishing Steel Car Equipment; Safety First as Regards the Paint Shop; Economy in Locomotive Painting; Paint Protection for Steel Freight Equipment; Silvering Mirrors; Removing Old Paint from Equipment, and Brushes. A. P. Dane, Reading, Mass., is the secretary.

New England Railroad Club.—The thirtieth annual meeting was held on March 11, 1913. The election of officers resulted as follows: President, C. B. Smith, mechanical engineer, Boston & Maine; vice-president, H. E. Astley, roadmaster, New York, New Haven & Hartford; treasurer C. W. Sherburne, Boston; finance committee, C. B. Smith, B. M Jones, F. A. Barbey. The new executive committee includes the officers and C. B. Breed, J. P. Snow, W. J. Cunningham, G. W. Wildin, E. W. Holst, F. O. Wellington, W. C. Kendall, P. M. Hammett and J. B. Hammill. The report of the secretary showed that the club has a membership of 578. The treasurer's report indicated a balance of $2,844.22 on hand.

Air Brake Association.—The annual convention will be held at the Planters Hotel, St. Louis, Mo., May 6-9. The subjects to be discussed and the committees selected are as follows: Will the Triple Valve Operate as Intended? That Depends, S. W. Dudley; Starting, Running and Stopping Long Freight Trains, F. B. Farmer; Undesired Quick Action, Its Prevention and Remedy, C. N. Remfry; Clasp Type of Foundation Brake Gear, T. L. Burton; Friction and Wear of Brake Shoes, Robert C. Augur; Recommended Practice, S. G. Down, chairman, Geo. R. Parker, H. A. Wahlert, J. R. Alexander, N. A. Campbell; Topical Subject, Air Hose Failures, T. W. Dow; Topical Subject, Steam Heat Drips, C. W. Martin.

Railway Fuel Association.—The following subjects will be discussed at the annual meeting, which will be held at the Hotel Sherman, Chicago, Ill., May 21-24:

Standard Form of Contract Covering the Purchase of Railway Fuel Coal.

Location, Construction, Development and Operation of a Bituminous Coal Mine.

Sub-Bituminous and Lignite Coal as a Locomotive Fuel.

Self-Propelled Railway Passenger Cars.

Scaling of Locomotive Boilers and Resultant Fuel Loss.

Modern Locomotive Coaling Station—Its Design, Construction, Operation and Maintenance.

The tentative plans for entertainment include a theater party on Wednesday evening, May 21; moving pictures of interior of mine works Thursday evening, May 22, and an automobile trip Friday afternoon, May 23.

Railway Storekeepers' Association.—The tenth annual convention of this association will be held at the Hotel Sherman, Chicago, Ill., May 19-21, 1913. The following regular subjects will be discussed:

Reducing Inactive and Disposing of Obsolete Stock.

Rolling Mills at Railroad Scrap Docks. Economy Effected.

Couplers and Parts, M. C. B. Marking by Manufacturers for Identification.

What Effect, if Any, Has a Well-Organized Store Department on the Operating Cost of a Railroad?

The topical subjects which will be brought up for discussion are as follows: Store House; Store-House Casting Platforms; Oil House and Waste Storage; Dry Lumber Shed; Stationary Store House; Supply Car; Scrap Dock and Reclaiming Machinery; Specifications for and Testing of Material, and Effect on Storekeepers' Stock; Ice—Proper Method of Storage; Disbursement, Shrinkage and General Handling on Railroads, and Standard Book of Rules Governing Store Department Practices.

Master Boiler Makers' Association.—The following subjects will be discussed at the annual convention, to be held at the Hotel Sherman, Chicago, Ill., May 26-29, 1913:

How many rows of expansion stays is it advisable to apply to the crown sheet to secure the most efficient service, considering the wear and tear of the boiler?

Is there any limit to the length of a tube in a boiler without a support midway of the boiler, and will a support prove objectionable in circulation?

When is a boiler in a weak and unsafe condition?

Best method of welding superheating tubes, and the tools used.

What effects do superheaters have on the life of fireboxes and flues?

What are the advantages or disadvantages of using oxy-acetylene and electric processes for boiler maintenance and repairs?

The proper inspection of a boiler while in service.

Best form of grate to be used to insure removing of fire at terminals with the least abuse to the firebox and flues, insuring the most economy as well as high efficiency in service.

The best method of applying and caring for flues while engines are on the road and at terminals.

Steel vs. iron tubes. What advantages and what success in welding them and advantages of either in maintenance, mileage, etc.

What benefit has been derived from treating feed water for locomotive boilers, chemically or otherwise?

The following list gives names of secretaries, dates of next or regular meetings, and places of meeting of mechanical associations.

AIR BRAKE ASSOCIATION.—F. M. Nellis, 53 State St., Boston, Mass. Convention, May 6-10, 1913, St. Louis, Mo.

AMERICAN RAILWAY MASTER MECHANICS' ASSOC.—J. W. Taylor, Old Colony building, Chicago. Convention, June 11-13, 1913, Atlantic City, N. J.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—A. R. Davis, Central of Georgia, Macon, Ga. Convention, July 22-24, 1913, Chicago, Ill.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa. Annual convention, June, 1913.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Annual meeting, December 3-6, Engineering Societies' Building, New York. Railroad session, Thursday morning, December 5.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 North Fiftieth Court, Chicago; 2d Monday in month, Chicago.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—C. G. Hall, 922 McCormick building, Chicago. Convention, May 21-24, 1913, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 829 W. Broadway, Winona, Minn. Convention, July 15-18, 1913, Chicago, Ill.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, Lima, Ohio. Convention, August 18, 1913. Richmond, Va.

MASTER BOILER MAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty St., New York. Convention, May 26-29, 1913, Chicago.

MASTER CAR BUILDERS' ASSOCIATION.—J. W. Taylor, Old Colony building, Chicago. Convention, June 16-18, 1913, Atlantic City, N. J.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOC. OF U. S. AND CANADA.—A P. Dane, B. & M., Reading, Mass. Convention, Sept. 9-12, 1913, Ottawa, Can.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio. Convention, May 19-21, 1913, Auditorium Hotel, Chicago, Ill.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. & H. R., East Buffalo, N. Y. Convention, August, 1913, Chicago, Ill.

PERSONALS

It is our desire to make these columns cover as completely as possible all the changes that take place in the mechanical departments of the railways of this country, and we shall greatly appreciate any assistance that our readers may give us in helping to bring this about.

GENERAL

The headquarters of W. L. Kellogg, superintendent of motive power of the Missouri, Kansas & Texas, have been transferred from Parsons, Kan., to Denison, Tex.

Max Fiedler, general foreman of the Globe shops of the Arizona Eastern, has been appointed assistant superintendent of the Globe division of that road.

John E. Gardner has been appointed electrical engineer of the Chicago, Burlington & Quincy, with headquarters at Chicago.

Fred Hooker has been appointed superintendent of locomotive fuel service of the St. Louis, Brownsville & Mexico, with headquarters at Kingsville, Tex.

B. G. Horton has been appointed superintendent of locomotive fuel service of the New Orleans, Texas & Mexico, with headquarters at DeQuincy, La.

Edward A. Park has been appointed superintendent of motive power and equipment of the Peoria & Pekin Union, with headquarters at Peoria, Ill., and the position of master mechanic, held by J. W. Hill, has been abolished.

C. A. Seley has resigned as mechanical engineer of the Rock Island Lines, effective May 1, to engage in a manufacturing business, the details of which will be announced later. This closes a career of 25 years of active railroad service. Mr. Seley was born December 26, 1856, at Wapella, Ill., and began railway work in 1879 as a draftsman for the St. Paul, Minneapolis & Manitoba. From 1881 to December, 1886, he was engaged in other work of a mechanical engineering nature, and then until January, 1888, was chief draftsman for the St. Paul & Duluth. The following four years he was with the Great Northern, and in May, 1892, he entered the railway supply business, returning to active railway service in March, 1895, as chief draftsman for the Chicago Great Western. He left the latter road in April, 1899, to become mechanical engineer of the Norfolk & Western, which position he held until May, 1902, when he was appointed mechanical engineer of the Rock Island Lines, with headquarters at Chicago. Mr. Seley has been an active member of various railway associations in committee work, and has served as a member of the executive committee of both the Master Car Builders' and Master Mechanics' Associations for many years. For three years prior to January 1 last he was a member of the sub-committee of mechanical officers of the Special Committee on Relations of Railway Operation to Legislation, which conducted the negotiations between the railways and the Interstate Commerce Commission and the post-office department on safety appliances, boiler inspection rules and steel postal car specifications. He acted as chairman of this sub-committee most of the time. Mr. Seley was president of the Western Railway Club in 1907 and 1908, and has been chairman of various committees. He is also author of many papers on railway electrification and on car, locomotive and boiler design. His varied experience has built up for him a very large acquaintanceship with railway mechanical officers and railway supply men throughout the country.

C. A. Seley.

J. W. Small, formerly assistant general manager (mechanical) of the Sunset-Central lines of the Southern Pacific, has been appointed superintendent of motive power of the Seaboard Air Line, with office at Portsmouth, Va., succeeding A. J. Poole, resigned.

O. Tefteller has been appointed superintendent of locomotive fuel service of the St. Louis, Brownsville & Mexico, with headquarters at Kingsville, Tex.

T. F. Underwood, whose appointment as master mechanic of the St. Louis & San Francisco, at Paris, Tex., was announced in the April issue of the *American Engineer*, was born at DeKalb, Mo., in 1859, and was educated in the public schools at Atchison, Kan. He commenced railroad work when 15 years old as a waterboy on the Atchison & Nebraska Railroad, now a part of the Burlington system. In April, 1876, he entered the Central Branch shops of the Union Pacific as a machinist apprentice, remaining there for 4 years, when he was transferred as a machinist to Atchison, Kan. Later he served as a machinist for the Atchison, Topeka & Santa Fe at Raton, N. Mex., and for the Chicago & Alton, at Bloomington, Ill., remaining in the latter position for two years, when he was appointed roundhouse foreman at Bowling Green, Mo. In May, 1888, he was appointed division foreman of the Atchison, Topeka & Santa Fe, at Atchison, Kan., and in February, 1893, was transferred to Emporia, Kan., as general foreman for the same company, in charge of locomotive and car work. In April, 1898, he was appointed division master mechanic of the same road at Winslow, Ariz., remaining there for one year, when he entered the service of the Kansas City, Fort Scott & Memphis as general foreman at Fort Scott, Kan. He was later transferred to Springfield, Mo., as general roundhouse foreman, remaining there until March, 1911, when he was appointed general foreman at Monett, Mo., in charge of locomotive and car department, the position which he held at the time of his recent appointment.

T. F. Underwood.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

O. C. Breisch has been appointed master mechanic of the Kansas City Terminal division of the Rock Island Lines at Armourdale, Kans.

J. R. Greiner, general foreman of the Cincinnati, Hamilton & Dayton, at Lima, Ohio, has been appointed master mechanic of the San Pedro, Los Angeles & Salt Lake, with headquarters at Milford, Utah, succeeding T. M. Vickers, resigned.

Frank Hopper, division master mechanic of the Chicago, Rock Island & Pacific at Estherville, Iowa, has been appointed master

mechanic of the Duluth, Winnipeg & Pacific, with headquarters at West Duluth, Minn.

F. A. HUSSEY has been appointed road foreman of engines of the Boston division of the Boston & Albany, with office at Beacon Park.

J. E. INGLING has been appointed road foreman of engines of the Erie at Jersey City, N. J.

J. LANG has been appointed road foreman of engines of the Buffalo division of the Erie.

M. E. MACKERLY has been appointed road foreman of engines of the Erie at Jersey City, N. J., succeeding J. A. Cooper, transferred.

MATTHEW F. REAGAN has been appointed road foreman of engines, on the Hudson division of the New York Central & Hudson River, with headquarters at West Albany, N. Y., succeeding W. P. Davis, promoted.

L. J. MCDONALD has been appointed road foreman of equipment of sub-divisions 30, 30-A and 31 of the Rock Island Lines, at Eldon, Iowa.

T. R. MCLEOD has been appointed master mechanic of the Canadian Northern Ontario, with office at Toronto, Ont., succeeding C. L. Webster, resigned.

CAR DEPARTMENT

SAMUEL LENZNER has been appointed master car builder of the Michigan Central, with headquarters at Detroit, Mich., succeeding D. C. Ross, resigned. Mr. Lenzner was born June 30, 1861, at Lancaster, N. Y., and has been with the Michigan Central since July 12, 1886, when he began railway work as a coach carpenter. In September, 1889, he was made foreman of the cabinet department, and in March, 1909, was advanced to general foreman of the car department, which position he held until his recent promotion.

JOHN OTTO has been appointed general foreman, car department of the Michigan Central at West Detroit, Mich., succeeding Samuel Lenzner, promoted.

D. C. ROSS, master car builder of the Michigan Central at West Detroit, Mich., has resigned.

SHOP AND ENGINE HOUSE

H. G. DORR has been appointed roundhouse foreman of the Rock Island Lines at Brooklyn, Iowa.

J. F. FITZSIMMONS has been appointed foreman boiler maker of the Erie at Hornell, N. Y., succeeding Jas. McNeil.

J. I. HALLER has been appointed fitting shop foreman of the Erie at Susquehanna, Pa., succeeding James Burrell, transferred.

FLOYD S. HARTWELL has been appointed night roundhouse foreman of the Rock Island Lines at Biddle, Ark.

J. H. MUSGROVE has been appointed roundhouse foreman of the Pittsburgh & Lake Erie at College, Pa.

J. M. RAY has been appointed machine foreman of the Atchison, Topeka & Santa Fe, at Amarillo, Tex.

F. J. STULL has been appointed assistant foreman boiler maker of the Erie at Hornell, N. Y., succeeding Robert McKenzie.

D. J. SULLIVAN has been appointed machine shop foreman of the Erie at Susquehanna, Pa., succeeding L. C. Emery, transferred.

C. W. WARCUP has been appointed assistant roundhouse foreman of the Rock Island Lines at Forty-seventh street, Chicago.

J. E. WHITEFORD has been appointed day roundhouse foreman of the Rock Island Lines at Cedar Rapids, Ia., succeeding W. H. Wenke, resigned.

NEW SHOPS

ATCHISON, TOPEKA & SANTA FE.—This company is planning to begin work shortly on a 12-stall roundhouse and shops at Wichita, Kan.

CANADIAN NORTHERN.—This company will enlarge its shops and increase its yard capacity at Pembina, N. D.

CHICAGO & ALTON.—A contract has been let to George B. Swift & Company for a 30-stall roundhouse, a coal tipple and ash pit at Glenn Yards, Chicago.

CHICAGO & NORTH WESTERN.—This company will build a new 40-stall engine house, brick power house, store and oil houses, mechanical coal chute, water tank, ice house, and other buildings in connection with track changes and other improvements at Green Bay, Wis., to cost approximately $350,000 in all.

CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA.—This company has begun work on a new 32-stall roundhouse, machine shops and other improvements at Altoona, Wis.

CINCINNATI, NEW ORLEANS & TEXAS PACIFIC.—Important improvements in the Ferguson shops near Somerset, Ky., are contemplated. The work includes an extension to the shop building, additional storehouse and repair track capacity, and the installation of a number of modern appliances.

DELAWARE & HUDSON.—Land has been purchased adjoining the shops of this company at Oneonta, N. Y., and several new buildings, including a coach shop, will be erected.

GALVESTON, HARRISBURG & SAN ANTONIO.—Repair shops and an 18-stall concrete engine house are to be erected at Del Rio, Tex.

LAKE SHORE & MICHIGAN SOUTHERN.—This company will build two roundhouses and a power plant at its Air Line Junction yards.

LOUISVILLE & NASHVILLE.—According to press reports the Louisville & Nashville is making plans for putting up a roundhouse, shops, etc., at Lexington, Ky.

NATIONAL TRANSCONTINENTAL.—A 12-stall engine house, without machine shop, will be constructed at O'Brien, Que.

PITTSBURGH & LAKE ERIE.—A contract has been let, it is said, for building a roundhouse, a shop structure, a storeroom and a power house at Dickerson Run, Pa.

SPOKANE, PORTLAND & SEATTLE.—This company has announced plans for the expenditure of $200,000 for roundhouses, car shops and storage tracks.

SPOKANE, PORTLAND & SEATTLE.—This company plans to erect a large engine house and shops at Overlook, Wash.

TEXAS & NEW ORLEANS.—Work has been begun on new machine shop buildings and other improvements at Beaumont, Tex., to cost about $40,000.

FREIGHT CARS IN PRUSSIA.—The average capacity of all Prussian freight cars in 1910 was 15.7 tons. Practically all of them have but two axles. Only one-third are fitted with brakes of any kind and only a very few of these with air brakes. Automatic couplers have not been adopted, although used experimentally. The standard box car of Prussia is 26 ft. long and has a capacity of 16.6 tons. Coal cars run in capacity from 22 to 40 tons, but those of the higher capacity are relatively few. The dead weight of the standard box car is 10.7 tons, or 65 per cent. of its capacity.—*Wm. J. Cunningham before the New York Railroad Club.*

Supply Trade Notes

The Gould Coupler Co. has moved its New York office from 347 Fifth avenue to 30 East Forty-second street.

The Grip Nut Company is moving its Chicago office from the Old Colony building to 661-663 McCormick building.

The Watson-Stillman Company, New York, has moved its Chicago office from the Rookery to the McCormick building.

The Yale & Towne Manufacturing Company, New York, has moved its general offices from 9 Murray street, to 9 East Fortieth street, New York.

The Horace L. Winslow Company, contractors and heating experts, has moved into new and larger offices at 990 Old Colony building, Chicago.

Henry Jungerman, formerly in the motive power and inspection department of the Harriman Lines, has been made railway representative of Tate-Jones & Company, Inc., Pittsburgh, Pa.

H. Martin Gower, formerly in charge of the apprentice work on the Canadian Pacific, has accepted a position in charge of the railway department of the A. R. Williams Machinery Company, of Winnipeg, Ltd., with headquarters at Winnipeg, Man.

Andrew Thompson, general manager of the Titanium Alloy Manufacturing Company, Niagara Falls, N. Y., will hereafter have charge of the sales of that company. A. C. Hawley has been made representative of the company for the Pittsburgh district, with office in Pittsburgh, Pa.

A. E. Rosenthal has resigned his position as western representative of the Lima Locomotive Corporation, Lima, Ohio, and the Chicago office of that concern has been temporarily discontinued. Mr. Rosenthal retains his position as president of the National Railway Equipment Company, Chicago.

Davis-Bournonville Company, manufacturers of oxy-acetylene welding and cutting apparatus, West Street building, New York, has removed its New York office to the Hudson Terminal building, 30 Church street. The Chicago sales office of the company has been moved from 515 Laflin street to rooms 202-206 Monadnock block.

At a meeting of the board of directors of the United States Light and Heating Company, held Thursday, April 17, Charles A. Starbuck was elected chairman of the board of directors, J. Allan Smith was elected president, Frank P. Frazier and William P. Hawley were elected vice-presidents, and A. H. Ackermann was elected general manager.

Charles Robbins, manager of the industrial and power department of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., with office in Pittsburgh, has been made assistant sales manager, with office at East Pittsburgh. J. M. Curtin, assistant manager of the industrial and power department, has been made manager of that department, succeeding Mr. Robbins.

Charles A. Lindstrom, chief engineer of the Pressed Steel Car Company, Pittsburgh, Pa., has been made assistant to the president, with headquarters in Pittsburgh; B. D. Lockwood, assistant chief engineer of the same company, has been made chief engineer; J. F. Streib, mechanical engineer of the company, has been made assistant chief engineer, and Felix Koch has been made mechanical engineer.

The Duff Manufacturing Company, Pittsburgh, Pa., has moved into its new plant and general office building on Preble avenue, Pittsburgh. The old works on Marion avenue have been dismantled. The new factory building has about 68,000 sq. ft. of floor space, and is located on a tract of ground approximately five acres. It has track connections with the Pennsylvania Railroad and the Baltimore & Ohio. This company is also planning to erect a new plant in the Chicago district, and one at either Windsor or Hamilton, Ont. Both of these plants are expected to be in operation in the fall of 1913.

On account of the rapid development of the business of the Dearborn Chemical Company in Canada, a Canadian company has been recently organized to carry on the business there, and make further extensions. A manufacturing plant is in process of erection at West Toronto, Ontario, with shipping facilities on both the Canadian Pacific and the Grand Trunk railways. The active head of the Canadian enterprise as vice-president and general manager is A. W. Crouch, who has been connected with the Dearborn Chemical Company for fifteen years, having established their Pittsburgh office, and been for the past eight years district manager, in charge of a number of branches. The Canadian company will specialize in the analysis and scientific treatment of boiler feed waters, both for steam railroads and stationary steam plants.

Willard Doud, who on April 1, resigned as shop engineer of the Illinois Central, to engage in special work on industrial engineering projects, terminates a railroad career of eleven years, devoted principally to the design, construction and supervision of railroad shops and power plants. After a course in mechanical engineering at the University of Illinois, Mr. Doud in 1902 entered the employ of the Kenefick Construction Company, Kansas City, who were engaged in railroad construction work in Indian Territory. He remained in this work until 1904, when he entered the mechanical department of the Kansas City Southern, at Pittsburg, Kansas, in the capacity of machinist's helper, later serving as draftsman and chief draftsman with this company. Mr. Doud entered the service of the Chicago, Burlington & Quincy in 1905 as draftsman on general locomotive and car design, and after two years in this work he was appointed shop engineer. While with the Burlington, Mr. Doud had general supervision over the mechanical end of shop improvements, and supervised the electrification of the West Burlington and the old Havelock shops, and had charge of the entire construction work of the new Havelock shops. In February, 1911, he entered the service of the Illinois Central as shop engineer, and during his two years' service with that company directed the work of electrifying Burnside, Waterloo and Memphis shops, the entire mechanical and electrical portion of the Centralia terminal, recently completed, and extensive improvements to the power plant equipment of the various shops Mr. Doud is located at 15 West Kinzie street, Chicago.

German Locomotives.—In a paper before the New York Railroad Club, W. J. Cunningham states that the Prussian passenger locomotive on through trains is considerably lighter than ours, but there is not as much difference as is generally supposed. In that class of service the Atlantic and 10-wheel type predominate. A large proportion of all locomotives is of the compound type. Germany is the home of the superheater and nearly all engines are equipped with the device, as well as feed water heaters, draft regulators, screw reversing gear, and other appliances which are not common here. The interior of the cab, especially in those equipped also with cab signals, seems somewhat complicated to the American observer. The tank locomotive, which is comparatively light, appears to be the favorite in local passenger service. Freight locomotives vary in size, but most of them are little more than half the size of our freight locomotive. With the small freight cars and light grades of the main lines, the length rather than the weight of the train is the controlling feature, and heavy engines are not needed. In Southern Germany, however, where the grades are heavier, there are many locomotives which in weight and power compare favorably with those of the American consolidation type. In 1910, Prussia had 19,670 locomotives of all kinds. This is an average of 84 locomotives per 100 miles of line.

CATALOGS

FORGING MACHINES.—National Header Talk Number 8, issued by the National Machinery Company, Tiffin, Ohio, deals with the National motor drive, wedge grip header, giving a description and illustrations.

BORING MACHINES.—The Betts Machine Company, Wilmington, Del., has issued a leaflet illustrating an extra heavy, double drive, 8 ft. boring and turning mill built for the new Canadian Pacific shops at Calgary, Alta.

BLACKSMITHING AND DROP FORGING.—This is the title of a 16-page bulletin issued by Tate-Jones & Company, Incorporated, Pittsburgh, Pa. It is the first of a series, and deals with welding, giving a number of illustrations.

AIR COMPRESSORS.—The Ingersoll-Rand Company, New York, has issued a 28-page booklet dealing with their class *PE* direct connected, electrically driven air compressors. This booklet gives instructions for installing and operating, and includes a duplicate part list.

GENERAL ELECTRIC BULLETINS.—Thompson Watt-hour meters is the subject of bulletin No. A-4092 recently issued by the General Electric Company, Schenectady, N. Y. Bulletin No. A-4087 is devoted to a brief description of direct current motor starting panels for heavy service.

SUPERHEATERS.—A 15 page booklet, issued by the Heine Safety Boiler Company, St. Louis, Mo., deals with that company's superheater for stationary use, and includes a reprint, from the *Journal of the Engineers' Society of Pennsylvania,* of a paper on Superheating, by C. R. D. Meier.

STOKERS' TOOLS.—The Economy Stokers' Tool Company, Portland, Maine, has issued a leaflet describing fire hoes, slice bars and pricker bars with detachable heads. The heads may be replaced easily by the fireman while on duty, making it unnecessary to take the tool to a blacksmith.

OIL SWITCHES.—The General Electric Company, Schenectady, N. Y., has issued Bulletin No. A-4113, describing small capacity oil switches, Type F, Forms P-3 and P-6, for induction motors of not over 25 h. p. capacity at 600 volts. This bulletin supersedes the company's previous bulletin on this subject.

ENGINE LATHE.—A quick change gear engine lathe that includes all the improved appliances and attachments that lead to greater convenience or an improvement in production is fully illustrated and described in a leaflet being issued by the Cincinnati Lathe & Tool Company, Oakley, Cincinnati, Ohio.

FEED WATER HEATERS.—In a booklet recently issued by the Hoppes Manufacturing Company, Springfield, Ohio, various types of exhaust steam feed water heaters and purifiers for power plants are illustrated and briefly described. The catalog also shows a number of designs of steam separators.

TURRET HEAD BORING MILL.—The Gisholt Machine Company, Madison, Wis., is sending out a leaflet, to be bound in a loose leaf binder, which illustrates a 52 in. boring mill with a turret head in the center and an auxiliary side head. Some of the more important advantages of this type of machine are briefly referred to.

GRAPHITE FOR THE BOILER.—Fine flake graphite when introduced into a boiler, penetrates the scale and gradually disintegrates and loosens it. A small leaflet issued by the Joseph Dixon Crucible Company, Jersey City, N. J., explains the process and gives instructions in the best method of introducing it in the boiler and the kind of graphite that has proved most successful.

ELECTRIC FANS.—The Sprague Electric Works of the General Electric Company, 527 West Thirty-fourth street, New York, is issuing an attractive decorated catalog, printed in colors, fully illustrating and describing a complete line of electric fans, showing them as arranged for ceiling, bracket or portable use. Prices of complete fans and of all the parts of the various designs are included.

HAMMER DIE.—William E. Sheehy, East Boston, Mass., has issued a leaflet describing the Sheehy free rocking-faced hammer die by which tapered forgings may easily be made. The rocking member is so supported that it may rock freely about a fixed axis, the desired taper being obtained by holding the work at the required angle to the face of the hammer. It will handle work up to 8 in. thick.

STEAM TURBINES.—Elbert Hubbard recently made a visit to the works of the Kerr Turbine Company, at Wellsville, N. Y., and has written a booklet entitled, "A Little Journey to the Home of the Economy Steam Turbine," which records his impressions. This is expressed in the author's well known distinctive style, and is most interesting. Copies are being issued by the Kerr Turbine Company.

HEATING WITH EXHAUST STEAM.—A special type of control valve has been designed by the Monash, Younker Company, New York, for use when exhaust steam from a power plant is employed for heating. This valve, together with various types of pressure regulating valves and vacuum pump governors, is illustrated and briefly described in a recent publication from that company. This design of radifier is claimed to be entirely noiseless and to give an unusually high efficiency.

MOLDING MACHINES.—Descriptions of jolt ramming machines in several sizes and operated by either electricity or compressed air, form the principal part of a catalog, designated as number 51, which is issued by the Mumford Molding Machine Company, Chicago, Ill. A variety of other machines that have proved their ability to produce economies in connection with molding are also illustrated and briefly described. These include hand and power squeezers, as well as vibrator machines, power riddles, etc.

DRILLING AND BORING OPERATIONS IN RAILWAY SHOPS.—An article written by P. G. Valentine of the Chicago, Milwaukee & St. Paul, which recently appeared in the *American Engineer,* is being published in pamphlet form by Pawling & Harnischfeger, Milwaukee, Wis. In addition to the interesting description of the method of doing certain classes of work in the Milwaukee shops, the pamphlet also includes some facts in connection with the horizontal drilling and boring machine manufactured by this company.

SHEARS AND PUNCHES.—A 24-page catalog from the Young Machine & Tool Company, Worcester, Mass., illustrates several arrangements of moderate sized punches and shears, both combined and as separate machines. With each style a table is included giving the range of sizes procurable, together with the weight, capacity and price. The catalog contains a brief illustrated description of some of the more important working parts of this design of punch and shear, and also illustrates an example of the type of engine lathe manufactured by the same company.

MOTOR DRIVEN TRACK CARS.—A leaflet describing the No. 3 triple ignition, motor car for railroad use is being issued by the Chicago Pneumatic Tool Company, Chicago. This car is arranged with a gasolene motor that drives through a series of clutches the same as an automobile. It is most substantially constructed for hard service and has two speeds ahead and two reverse. The reverse speeds are the same as those ahead, so that the car may be operated in either direction. A 4 h. p. motor is supplied, which gives the car a speed of 25 miles per hour.

BRIQUETTES.—A brief, comprehensive description of the making and use of briquettes, particularly as applied to this country, is included in a catalog issued by Renfrow Briquette Company,

Central National Bank building, St. Louis, Mo. An illustrated description of the Renfrow coalette press, which produces briquettes of an ovid round shape about 3½ in. in diameter, and 2½ in. thick weighing from 13 oz. to 16 oz., occupies part of this booklet. A discussion of the grades of coal that have proved suitable for this work, as well as a discussion of the best binders and a full description of the process of making coalettes, is given.

CHAIN GRATE STOKERS.—An analysis of some 300 samples of coal from mines in practically every coal producing district in this country and some from abroad, is included in a catalog issued by the Illinois Stoker Company, Alton, Ill. This company's type of chain grate stoker is illustrated and described in detail, and illustrations showing its application to various types of boiler are given. An efficiency table based on the evaporation from and at 212 deg. F., giving the evaporation per pound of coal and the pounds of coal per horse power per hour that correspond to various ranges of efficiency from 50 per cent. to 80 per cent., and with coals having from 7,500 B. t. u. per pound to 14,500 B. t. u. per pound, is also included.

RAILROAD MOTOR CARS.—Complete illustrations and descriptions of four different types of gasolene railway motor cars are included in catolog No. 101, issued by Mudge & Company, Peoples Gas building, Chicago. These include a light inspection car suitable for signalmen, telegraph linemen, inspectors, etc., a light section car for maintenance work, a heavy car for carrying large section and work gangs, and for performing heavy service, which is driven by the Jacobs design of four-cycle engine, and the Au-Tra-Kar, which is a portable power plant car designed primarily for laying tracks with screw spikes, and is also suitable for many other classes of construction work. These cars and their parts are very fully described, and the illustrations show them in operation. A price list of motor car accessories is included.

GENERATING OXYGEN AND HYDROGEN.—The principle of the system for the generation of oxygen and hydrogen that forms the basis of the apparatus designed by the International Oxygen Company, 115 Broadway, New York, is the separation of water into its elements by means of electricity. The apparatus consists of generators or cells each capable of producing 3 cu. ft. of oxygen and 6 cu. ft. of hydrogen an hour. The operation of the cells is entirely automatic and it is only necessary to fill them with a little less than a gallon of distilled water for twenty-four hours' operation. Pamphet No. 9 from this company discusses the operation of this system and gives a comparison of costs with other methods of obtaining oxygen or hydrogen. The apparatus is illustrated and tests of it are given. Bulletin No. 10 from the same company gives a complete description of the apparatus.

CLOTH PINIONS.—A new departure in noiseless pinions is described in bulletin No. A-4110, published by the General Electric Company, Schenectady, N. Y. These gears are made of a cloth or cotton filler compressed under a hydraulic pressure of several tons per square inch, and are held in compression by steel shrouds and threaded studs passing entirely through both the shrouds and the filler. They are applicable and especially desirable on a large number of machine tools, such as lathes, planers, traveling cranes, drill presses, punches, etc. It is claimed that they are as strong as the best grade of cast iron, that they are not liable to damage from contact with oil, that they are unaffected by atmospheric changes. They may be stored for an indefinite time without damage, are vermin proof, and have sufficient elasticity to absorb shocks. Beveled pinions, however, cannot be supplied. The bulletin also contains data relative to tooth dimensions and instructions for selecting the proper pinions.

LITTLE BREAKS.—A little break in an air brake hose often means a resultant expense many times larger than the cost of new hose for many cars. Guilford S. Wood, Great Northern building, Chicago, Ill., is issuing a leaflet drawing attention to air hose failures, pointing out at what point on the hose the greatest number of failures occur, what causes them and how they may be prevented. This discussion of the subject is interesting and convincing. Data are given showing the causes of failure in the percentage of total number, and the illustrations show how air brake hose usually fails. Among other features this booklet points out that 10 per cent. of the bursted hose fails on account of an internal puncture due to mounting by improper devices. Recent investigations have shown that it takes longer to mount the fittings by machinery than by hand, and that machine mounted hose is very liable to be punctured. The test developed that eight out of ten pieces of hose mounted by an air machine were punctured in the inner tube before going into service.

ELECTRIC DRIVEN AIR COMPRESSORS.—Two publications on duplex, direct connected, electric driven air compressors are being issued by the Ingersoll-Rand Company, 11 Broadway, New York. The first, designated as No. 3008, fully describes this compressor, devoting 40 pages to illustrations of the various details and a discussion of the design. Among the principal features shown is an automatic clearance controller which consists of a number of clearance pockets which are automatically thrown in communication with the ends of each air cylinder in proper succession, the process being controlled by a predetermined variation in the receiver pressure. The hurricane inlet valve is a development of the original Sargent piston inlet valve, and is so arranged that there can be no escape of clearance air. The inlet valve cannot open until the air in the clearance space has expanded down to the intake pressure. This valve is made very light to prevent shock when opening or closing. A large water separator or moisture trap is placed on the discharge pipe of the intercooler of this type of compressor when of 18 in. stroke and larger. This will separate entrained moisture from the air and insures the delivery of practically dry air to the high pressure cylinder. A separate booklet, designated as Form No. 575, contains instructions for installing and operating this type of compressor. It also includes a duplicate part list.

PERFORMANCE OF GERMAN LOCOMOTIVES.—William J. Cunningham in a recent paper before the New York Railroad Club, reported that the cost of maintaining locomotives in Prussia in 1910 averaged 4.8 cents per mile, which indicates commendable efficiency even when due allowance is made for their small size. Failures are infrequent and the locomotives generally have the appearance of being well maintained. The Prussian policy differs from ours in that they expect and obtain a comparatively long life from their locomotives. The average life of all locomotives in 1910 was 10.2 years. One-quarter of the entire equipment ranged from 10 to 20 years in service; 45 per cent. ran from 5 to 10 years; and 22 per cent. had an average age of less than 5 years. The average mileage per locomotive in 1910 was 25,600. The same average for this country was approximately 29,100. The Prussian statistics showing the performance of locomotives are remarkably complete. Among other things they give the number of days all locomotives were in service, the per cent. of time in actual use, and the per cent. of time they were in the shops for repairs. They were actually used in train service 32.79 per cent. of their time; 18.91 per cent. of their time was spent in the shops for repairs; leaving 48.3 per cent. of the time when they were idle in or near the engine house. The high proportion of time idle is accounted for by their policy of single crewing. When not single-crewed, it is the general practice to assign one engine to two crews. Enginemen are required to do much of the light running repairs themselves, and on single-crewed engines the fireman is required to report at the engine house two hours in advance of leaving time, in which to kindle the fire and get up steam. At the end of the trip it is his duty to clean the fire and do other work which here is done by the engine house forces.